POWER

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Oil and Gas Power Week

PETROLEUM — *petra*, a rock, *oleum*, oil, rock-oil—has been known to man since he began to notice, but it is only recently that he has learned its abundant potentialities and qualified himself to take advantage of them.

Its first large use was for illuminating oil, kerosene, and millions of dollars' worth of the lighter and heavier products of its distillation were allowed to escape.

And then the value of the heavier distillates as lubricants was developed. It is difficult to imagine how the growing demand for lubricants for engines and turbines with their increasing pressures and temperatures, of mill machinery and rolling stock with their high speeds and heavy bearing pressures, would have been met without this opportune supply.

And then came the internal-combustion engine, at first with gas and then with liquid fuels, creating such a demand for the volatile products that human ingenuity has been taxed to break the crude down into a larger proportion of these constituents formerly of such little use. And last the Diesel and other heavy oil engines.

In the automobile and auto truck, in agricultural and road-making and contractors' machinery, in marine transportation from the small motor boat to the large Diesel-driven liner, in truck and bus transportation, motor-driven railroad cars and switching engines, in the whole field of aeronautics, in the blast-furnace gas engines of the steel industry, in Diesel and semi-Diesel engines in factories, public utilities, refrigerating plants, office buildings, department stores, etc., there is installed a greater aggregate capacity of internal-combustion engine than in all the steam- and water-driven prime movers of the country combined.

Can you form any conception of the void that would be left if petroleum and its products were taken out of our list of resources?

Nobody knows how much we have left or how long it will last, whether we are drawing entirely upon a heritage of the ages or whether it is still forming.

But it does behoove us as intelligent creatures, and especially as engineers, to take account of our stock in this resource that has become of such commanding importance, to appraise the value and the possibilities of this newest and most efficient, and, for some purposes, the most practicable and convenient type of motor in our industrial and social economy.

And so the spot light has been turned upon the subject, and from April 20 to 25 the engineers and the public will be asked to direct their attention to it in a National Oil and Gas Power Week.

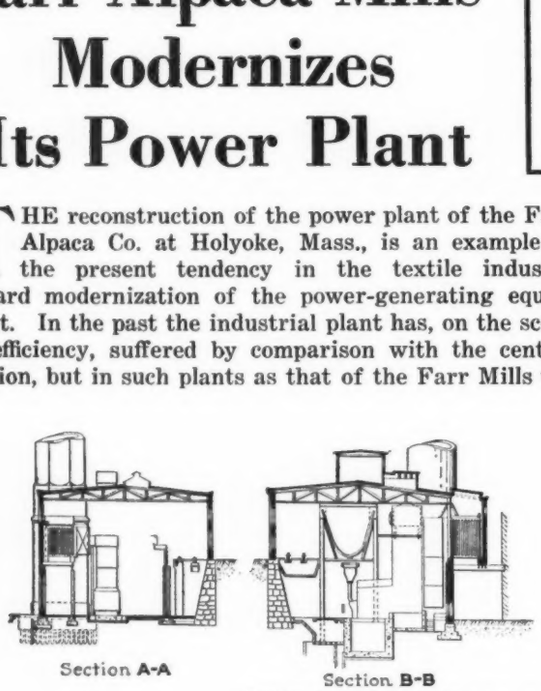
Eighteen national engineering bodies and a host of local engineering societies will hold meetings and discussions upon the best ways to conserve and to utilize efficiently and economically our gaseous and liquid fuels and the engines that have been developed for their conversion into power. Papers will be forthcoming from outstanding authorities, and it is hoped that the best thought of engineers, oil producers, publicists and all interested may be concentrated upon a topic the intelligent handling of which is of universal and immediate concern.

F. R. Low

Farr Alpaca Mills Modernizes Its Power Plant

BLEEDER turbine supplies low-pressure steam for dyehouse. Condensate used as hot water supply. Water tube boilers and pulverized coal equipment replace twenty 2,300 sq.ft. hand-fired vertical tubular boilers.

THE reconstruction of the power plant of the Farr Alpaca Co. at Holyoke, Mass., is an example of the present tendency in the textile industry toward modernization of the power-generating equipment. In the past the industrial plant has, on the score of efficiency, suffered by comparison with the central station, but in such plants as that of the Farr Mills the efficiency obtained far exceeds that of plants making no use of the steam after passing through the generating units.



Originally, the Farr Alpaca Co., which manufactures mohair, coat linings, etc., operated a worsted spinning and weaving mill. Power was obtained both from a waterwheel taking water from the Holyoke Canal and from a steam turbine. In addition, there was a large dyehouse and finishing mill about 2,500 ft. away from the other buildings.

This contained a 1,500-kw. steam turbine exhausting into a surface condenser at about 5 in. vacuum. The condensate from the hotwell was delivered to a 150,000-gal. hot-water tank for use in the dyehouse. The average load was approximately 1200 kw., but the load at any stated time was held at such a value that the hot-water supply was kept at the correct temperature, the rest of the load being carried by the spinning-mill plant.

The dyehouse boiler plant consisted of seven 2,000-sq.ft. and twenty 2,500-sq.ft. Manning vertical fire-tube boilers, all hand fired, as well as four 5,000-sq.ft. vertical water-tube boilers equipped with stokers. The dyehouse required approximately 250,000 lb. of steam, which was supplied at 80 lb., and the steam to the turbine was carried at 150 lb.

The consulting engineer for the mill felt that it was entirely unnecessary and uneconomical to supply high-pressure steam to the dye kettles, although dyehouse tradition held that it was necessary if quality and quantity of output were to be maintained. To settle the matter, two kettles were piped to take steam at 15 lb. gage and an automatic temperature control was placed on the kettles to enable a set temperature to be carried. It was found that there were no unfavorable results in the kettle action; in fact, a saving of 20 per cent was obtained and it was planned to use low-pressure steam as soon as the new cotton mill was built.

This mill was placed between the dyehouse and spinning mill, and to carry the additional load a 3,500-kw. bleeder turbine was put in. This turbine is designed to operate on 225-lb. steam at 100-deg. superheat and will deliver 3,500 kw. using 126,000 lb. of steam, of which 122,000 may be bled at 15-lb. gage for use in the dyehouse. When delivering 2,625 kw., 87,300 lb. may be bled and the total consumption will be 91,350 lb. At 1,750 kw. output 65,400 lb. will be used, of which 61,400 is to be bled.

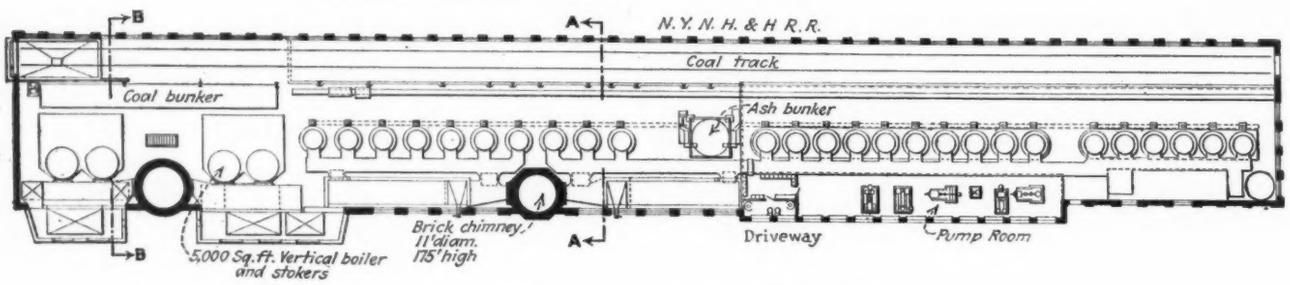


Fig. 1—Arrangement of old boiler plant

The water-rate guarantee on the turbine with 2 in. vacuum is 14.9 lb. per kw.-hr. at 3,500 kw., 14.9 lb. at 2,625 kw. and 15.8 lb. of steam per kilowatt-hour with an output of 1,750 kilowatts.

The condensate from the 7,500-kw. turbine is picked up by the circulating pump of the 1,600-kw. turbine, which is in the same room, and is heated to 180 deg. F. in the heater condenser. The water flow is hand regulated to give the required outlet temperature, but steps are now being taken to install an automatic temperature regulator that will control the condensing-water flow so as to maintain a constant exit temperature. Since the dyehouse shuts down early in the afternoon, the hot water from the turbines is stored for use next day. In that way the turbine efficiency is kept high at all times.

The layout of the old boiler plant is shown in Fig. 1.

Coal was moved into the plant and dumped into a hopper, crushed, and after being lifted by a bucket elevator, was conveyed to the binders in front of the stokers under the water-tube boilers. Ashes were delivered by elevators and a scraper conveyor to an ash bunker. Coal for the fire-tube boilers was delivered by the conveyors to a pile in front of each boiler.

It was decided to remove the old fire-tube boilers and install four 10,000-sq.ft. cross-drum water-tube boilers and pulverized-coal equipment. The mills could not be closed down during the period of alteration and the remodeling proceeded by piecemeal. To permit the installation of the pulverized-coal equipment, the headroom above the old fire-tube boilers was increased as shown in Fig. 2. Three of the boilers were removed from the space *AB* to provide a location for one of the new boilers. The boiler-feed pumps were kept in operation until two of the boilers were installed, whereupon three of the fire-tube boilers were taken out and the space used for the new pumproom. The coal conveyor was extended to an elevator over the pulverizing coal equipment, and the coal, after passing over a magnetic separator, drops into a coal bin shown in section at *MM*, Fig. 2.

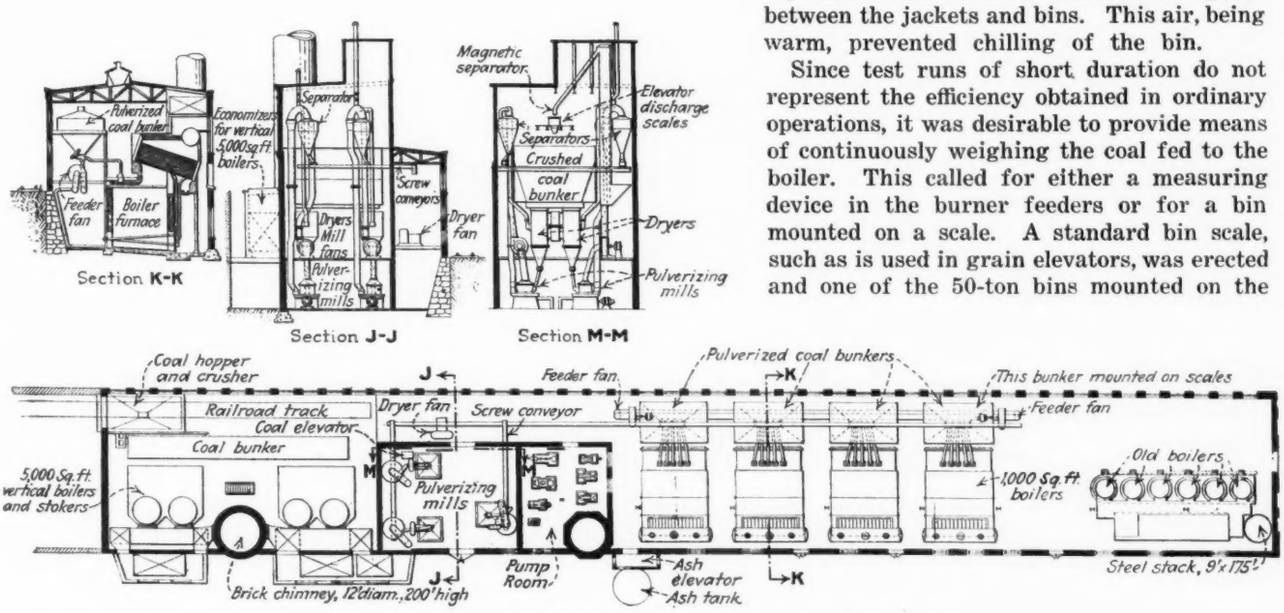


Fig. 2—Location of pulverized-coal equipment and new boilers

The coal from this bin passes through three driers of the flue-gas type. Part of the stack gas is drawn into a duct and forced through the coal drier, the inlet-gas temperature being around 350 deg. F. The process of pulverizing, separating and conveying the powdered coal to the boiler furnace is similar to many other plants. However, the mills present one item of interest in that arrangements have been made to regulate the coal feed to the pulverizer by the air pressure in the separator. If the coal feed to the pulverizer becomes light, the air pressure in the separator increases by reason of the less resistance in the pulverizer. Advantage is taken of this pressure variation to control the pulverizer feed. A tube from the separator is connected to a Mercoid control, which in turn opens and closes the circuit of a solenoid which lifts the pawls of the coal feed in case the separator air pressure decreases or rises one or more pawls when the pressure increases. The pulverized coal, as is usual with the Raymond mill, is fed by a long screw conveyor to 50-ton bins, one of which is placed in front of each of the new boilers. From the bin five screw feeders deliver the fuel into the burners located in the front of the furnace and two motor-driven fans supply the air for the burners at 5 lb. gage, drawing the supply from beneath the floor of the boiler furnaces. In this way the flat bottom of the furnace is kept cool and the heat recovered. This air is about 25 per cent of the amount needed for combustion; the remainder comes into the back of the furnace, circulating around through the side walls and into the front of the furnace.

Warm Air Jackets on Bins

The steel storage bins were found to sweat due to the cooling of the coal and entrained water vapor below the dew point, and the coal tended to "bridge." To eliminate the sweating an outer steel jacket was placed around each bin and a fan arranged to take air from across the tops of the boiler and circulate it in the spaces between the jackets and bins. This air, being warm, prevented chilling of the bin.

Since test runs of short duration do not represent the efficiency obtained in ordinary operations, it was desirable to provide means of continuously weighing the coal fed to the boiler. This called for either a measuring device in the burner feeders or for a bin mounted on a scale. A standard bin scale, such as is used in grain elevators, was erected and one of the 50-ton bins mounted on the scale. To eliminate error, the feeder pipes were fitted with flexible connections, but later rigid connections were used and the error was found to be less than 10 pounds, an insignificant percentage.

In view of the character of the location it was impossible to use a hopper-bottomed furnace and a flat bottom was necessary. The ash and slag accumulates over the entire bottom, and to make their removal easy a row of steam jets is introduced at the front end of the furnace a few inches from the bottom. The action of the jets when steam is turned on causes the furnace floor to be scoured of the ash, piling it up at the rear, where removal is comparatively easy.

The cross-drum boilers are jacketed by steel casings lined with insulating brick. Each furnace required 15,000 of this brick, 48,700 firebrick, 3,500 common brick, 22 tons of fireclay and 800 lb. of asbestos. The steel casing cost $4,718 and the brick settings, including labor, cost $11,800 each; the labor cost of laying the firebrick was $44 per thousand.

The centrifugal boiler-feed pumps are driven by non-condensing steam turbines, the exhaust heating the feed water. The pump suction is under a slight head from the canal, and the water, after passing through the heater, enters a storage tank. This tank has an overflow that is connected to the pump and the suction-line check boiler. If the tank overflows, the heat in the overflow pipe closes the suction check and the pump merely circulates the water in the heater and tank; in this way the temperature is kept as high as possible. When the tank level lowers, the suction check opens and pumping from the canal is resumed. The furnace arrangement is shown in Fig. 3.

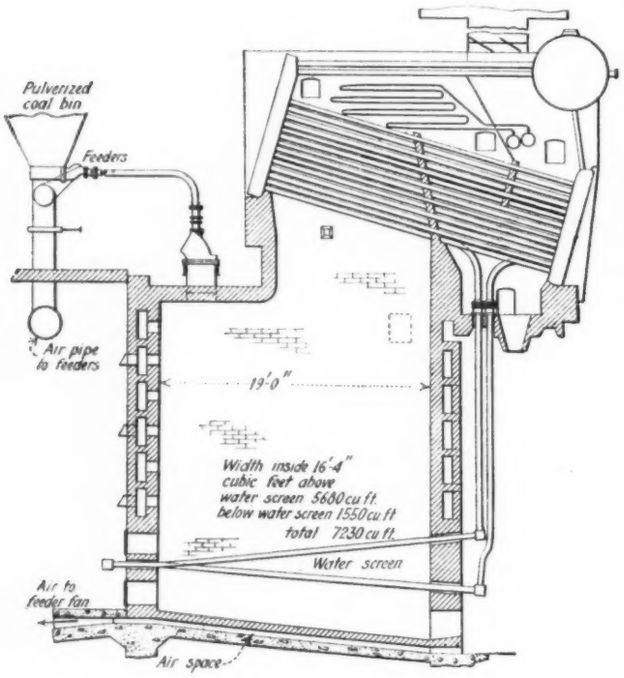


Fig. 3—Cross-section of furnace

The alterations and additions were under the supervision of Samuel M. Green, consulting engineer, Springfield, Mass., to whom *Power* is indebted for the data on this plant.

Operation of Refrigeration Plants*

By Charles H. Herter

An improvement has been effected in certain high-speed ammonia compressors by placing enlarged plate valves in the original valve cage cavities, as first suggested by J. H. H. Voss. Another feature contributing to a reduction in horsepower has been the deepening of the valve pockets so that the gas could pass with the least amount of wiredrawing. This deepening was done by the use of a special milling cutter held at an angle and worked like a ratchet drill. On some high-speed compressors these pockets were found to be unnecessarily deep, and when filled up with a half-round steel plate ½ in thick, the excess clearance was sufficiently reduced to enable the cylinder to increase its capacity materially.

Excellent results have been obtained with piston rings made of a brass alloy in compressors having center ports. Leakage of ammonia at stuffing boxes has been effectually prevented by means of special rod packing. Asbestos sheet packing is cheaper and far superior to sheet lead gaskets, and suitable for all purposes about a plant.

The installation of heat exchangers for removing the superheat of air and gas also helps extract oil from the pipe system, while yielding warm water for thawing ice out of cans in winter, and is an excellent investment for any plant. Among other economies that can be effected by an engineer is the passing of the intake air through a snow box, thus utilizing the sweepings and damaged ice from the storage rooms and saving power in air compressors.

In one case the rate of water circulation over the cooling tower and condensers was materially increased with the existing centrifugal pumps by merely doubling the flow area of the mains and substituting long-radius elbows for short ones. The placing of a ¼-in. steel plate having ⅝-in. diameter perforations over condenser outlets keeps wood and other obstructions out of centrifugal water pumps.

To reduce greatly the waste of water flowing through thawing tanks, the supply can be controlled by a ball float and the water introduced at the bottom, in this way creating an agitation. To reduce wear in dip tanks these should be protected by wooden fenders.

To keep the brine in tanks clean and efficient, the use of pure white mineral salt, dissolved outside the tank in a special salt dissolver, and the passing of full-strength brine through a filter containing excelsior is recommended.

Proper dial indicators on expansion valves, to reduce guesswork as to the amount of opening normally required, are of advantage. Coils should be short, say 200 to 400 ft. of 1¼-in. pipe, rather than 600 or 800 ft., to give the gas a chance to escape and not be dragged uselessly through more pipe. One plant is now installing freezing tank coils with a continuous upward pitch, and equipped with a concentric glass within glass liquid level gage, to see whether liquid can be fed up to the end of the sixth pipe from the bottom.

A new type of slide-rule construction which secures constant smoothness of working without tendency to stick, is described in the March 27 issue of the *Mechanical World* (London). This rule, called the "Glider," has a narrow slot in the slide extending to within one-quarter inch at each end. Within this slot is fixed a narrow waved spring of steel which presses the two sides of the slide apart. The pressure thus provided is said to insure just that frictional grip necessary to give even working. It is evident that this construction automatically compensates for shrinking or swelling of either the slot or the slide. The rule is made by Messrs. John Davis & Son, of Derby, England.

"A few of the reasons for boiler explosions are: Defective design; ignorance as to the amount of pressure the boiler will stand; reduction in strength by deterioration; defective workmanship and material; mismanagement; overheating of plates caused by low water, accumulation of scale, oil, mud, or other deposits preventing the water gaining access to the plates; defective safety appliances; obstruction between safety valve and boiler."

*Abstract of address before the New York Chapter, National Association of Practical Refrigerating Engineers, Mar. 19, 1925.

Photographing an Air Jet

By A. J. NICHOLAS*

AN ORIFICE is a simple and convenient piece of apparatus for measuring capacities of compressors and other air pumps, but its use is generally limited to low-pressure drops because not much is known about its laws of flow for high-pressure drops. The term "orifice" is here restricted to orifices in thin plates, or sharp-edge orifices.

An experimental study was made on a half-inch orifice in the mechanical engineering laboratory of the Pennsylvania State College. Compressed air, with fairly high pressure drops, was used in these experiments. A simple device was rigged up by means of which it was possible to photograph a jet of air blowing from the orifice into the laboratory. The readers of *Power* may be interested in seeing these photographs and learning how they were made.

Description of Apparatus

The apparatus was arranged as in Fig. 1. Light was furnished by an automobile headlight with a 12-16 volt bulb (21 cp.), mounted on an adjustable stand. The lens was removed and a tin cover made for the face, with a ¼-in. hole in its center. This opening gave

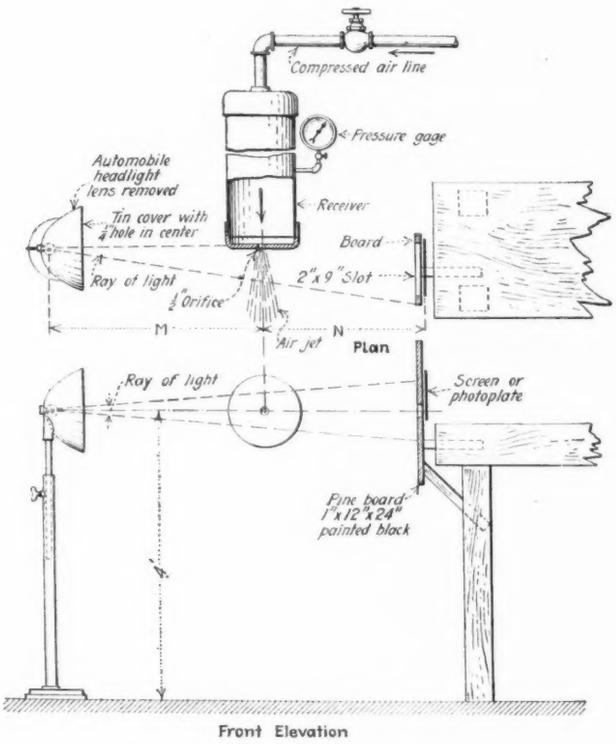


Fig. 1—Arrangement of apparatus

a ray of light as shown. Compressed air was delivered through a ½-in. sharp-edged orifice at one end of a receiver made of a 4-in. pipe 3 ft. long. The receiver pressure was controlled by a valve.

*Instructor in Mechanical Engineering, Pennsylvania State College.

The following scheme was used in photographing a jet: The headlight and the board (shown at the right) were placed in line with the orifice as shown in the plan view, Fig. 1. With the laboratory in complete darkness except for the ray of light from the headlight,

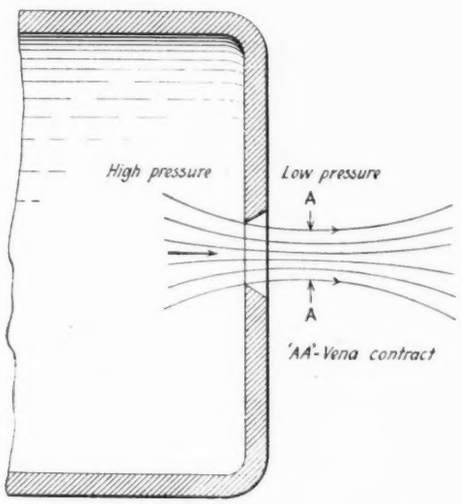


Fig. 2—The "Vena Contracta" here shown does not occur above the critical pressure

and with the air blowing out of the orifice into the laboratory, a shadow of the jet was cast on a screen placed at the board. By moving the lamp and the board to and from the orifice, distances were found for *M* and *N* which gave a very pretty shadow at the board.

Jet Photographed Without a Lens

The light and the board were so manipulated as to cause the shadow to fall on the 2x9-in. slit in the board. After adjusting the pressure in the receivers at some desired value, the light was put out. Then an 8x10-in. photographic plate was placed behind the board, and the light was switched on long enough to expose the shadow of the jet on the plate. The photographs in Fig. 3 were taken in this manner, with gradually increasing pressures as indicated. Distances *M* and *N* were equal to 6 ft., 2¾ in. and 12 ft., 2 in. respectively.

It will be noticed that photograph No. 1, taken at 10 lb. receiver pressure, was a slender stream. No. 2, at 12.5 lb. pressure, showed peculiar, perpendicular bright disks crossing the stream at fairly equidistant points. At pressures below this the stream appeared as in No. 1. With pressures greater than 12.5 the distance between the disks increased. It was expected that the jet would issue something like the stream flow of Fig. 2. Actually, the photographs show a stream of considerably swollen dimensions demonstrating that an air jet flowing from an orifice into the air has no "vena contracta" at the critical or higher pressures. Fig. 2 shows the condition existing below the critical pressure. The second photograph was taken at exactly the critical pressure, which also first showed the peculiar markings

in the stream. The distance between consecutive markings is the length of the stationary sound wave in the moving jet, which is different for the different pressures indicated.

In the course of the foregoing study many helpful suggestions were given by Professors A. J. Wood, H. A. Everett, and especially L. J. Bradford and C. C. Cochran, all from the mechanical engineering department of Pennsylvania State College, for which due acknowledgment is made.

[Everyone has noticed the so-called "heat waves" that rise from steel rails and tar roofs on hot summer days. These are due to the mingling bodies of air at different temperatures. Light passing from air at one temperature to that at another is deflected just as light is bent in passing from glass to air or the reverse. Thus a portion of heated air may act as a lens and focus light. In the experiments of Mr. Nicholas it appears that the standing waves present in the jet created some sections of high and others of low pressure capable of focusing a beam of light into the curious patterns shown. The meaning of the standing waves themselves is not so clear except that complicated motion generally implies complicated formulas. Work of this kind typifies the modern tendency to look back of scholastic assumptions to see what is really going on.—Editor.]

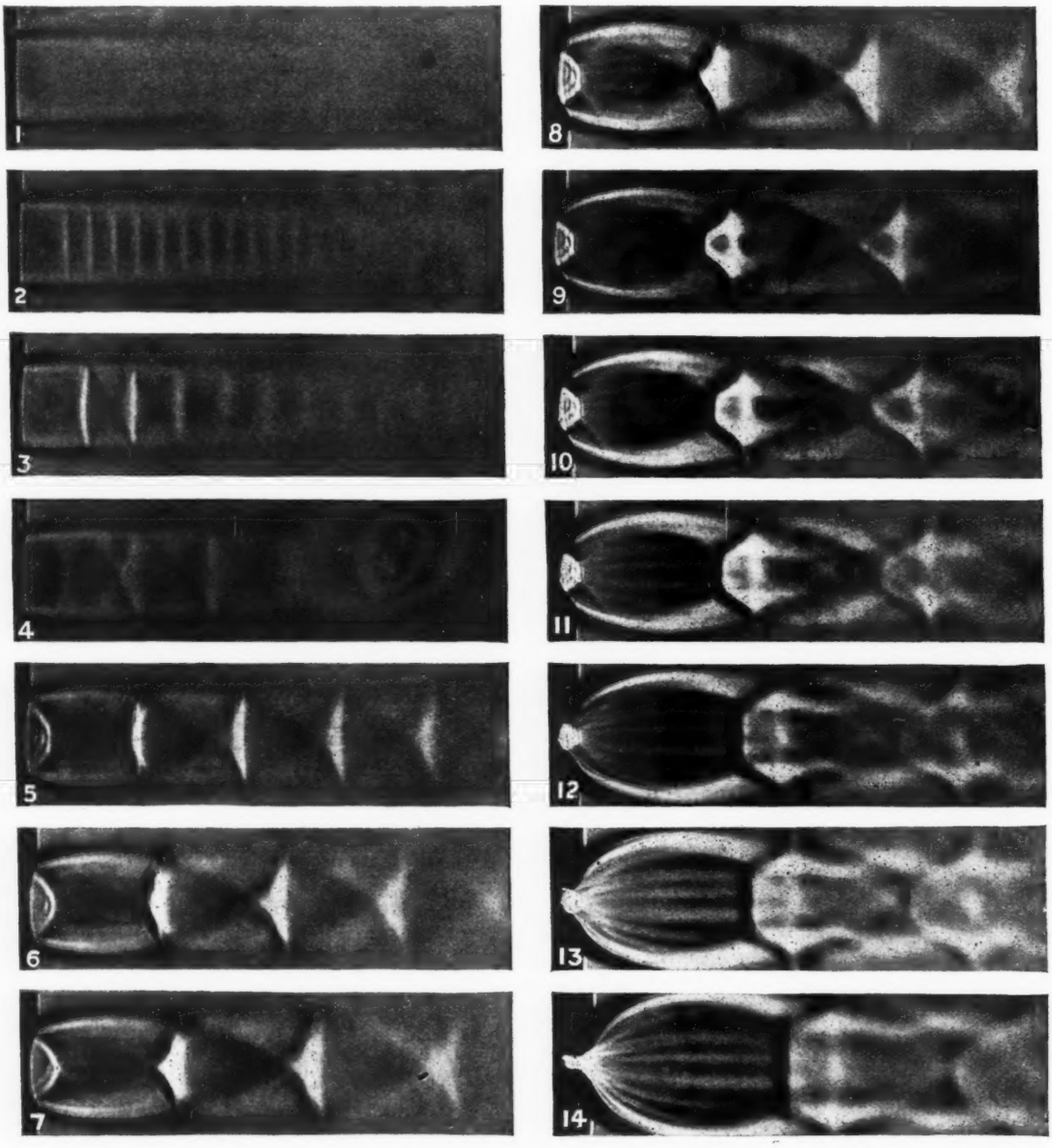
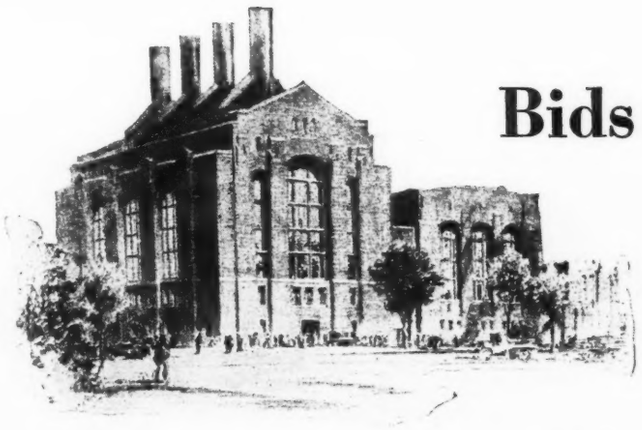


Fig. 3—Air-jet photographs taken by transmitted light without a lens. Note the perpendicular bright disks crossing the stream

Air pressures (gage) were as follows:

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Lb.	10	12.5	15	20	24.5	29.3	35	45	49	54	60	80	86	120



Bids on Boiler Auxiliary Equipment of Detroit Municipal Plant

FROM time to time as they became available, *Power* has published the bids on the mechanical equipment to be installed in the new Morrell Street municipal plant in Detroit, as tabulated by the architects and engineers, Smith, Hinchman & Grylls. Tables on the boilers, condensers and auxiliaries and other equipment have appeared in these columns[1] and in the tables just released, which are being presented herewith, the competitive data on the powdered-coal equipment, air preheaters, economizers and furnace water walls are made available. Engineering data in addition to the cost figures make these tables of special interest, in particular as such information is seldom available.

Other tables on the remaining equipment soon will be ready for publication. It may be of interest to state that the contracts for the air preheaters, furnace water walls and powdered-coal equipment were awarded to the Combustion Engineering Corporation and the contract for the economizers to B. F. Sturtevant Co.

[1]See *Power*, Aug. 28, 1923, Nov. 27, 1923, Dec. 11, 1923 and Oct. 21, 1924.

Air Preheaters

	Bidder		Combustion Engineering Corp.				James Howden & Co. of America							
			Alternate No. 1		Alternate No. 2		Alternate No. 1		Alternate No. 2		Alternate No. 3		Alternate No. 4	
	Price		$61,890		$61,890		$109,290		$109,290		$132,030		$132,030	
				Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1.	Delivery time, weeks		1st htr. —8 wk. 1 per wk. thereafter	15	1st htr. —8 wk. 1 per wk. thereafter		52	10	52	10	52	10	52	10
2.	Erection time, weeks		15 wk. from 1st delivery	15	15 wk. from 1st delivery		12	10	12	10	12	10	12	10
3.	Net weight per boiler unit, lb.		100,000	2			60,000	10	60,000	10	90,000	10	90,000	10
4.	Temp. (deg. F.) of air leaving preheater when inlet air is at 65 deg. F. and weight of air, weight of flue gas, and its initial temp. are:	57,200 lb. per hr. 62,000 lb. per hr. 345 deg. F.	200	2	200		293	10	*407	10	295	10	*415	10
		107,100 lb. per hr. 116,000 lb. per hr. 385 deg. F.	215	2	215		308	10	*460	10	310	10	*465	10
		159,700 lb. per hr. 173,000 lb. per hr. 440 deg. F.	240	2	240		331	10	*498	10	340	10	*520	10
5.	Static pressure drop of air (inches of water) through air preheater under conditions of item (4):	62,000 lb per hr. flue gas	0.40	10	0.40		.11	10	0.11	10	0.10	10	0.10	10
		116,000 lb. per hr. flue gas	0.80	10	0.80		0.39	10	0.39	10	0.25	10	0.25	10
		173,000 lb. per hr. flue gas	1.45	10	1.45		0.78	10	0.78	10	0.50	10	0.50	10
6.	Temperature (deg. F.) of gases leaving air preheater under conditions of item (4):	62,000 lb. per hr. flue gas	220	2	220		157	10	203	10	150	10	220	10
		116,000 lb. per hr. flue gas	240	2	240		186	10	264	10	180	10	255	10
		173,000 lb. per hr. flue gas	280	2	280		218	10	322	10	215	10	310	10
7.	Draft loss (inches of water) of gases through air preheater under conditions of item (4):	62,000 lb. per hr. flue gas	0.25	10	0.25		0.13	10	0.13	10	0.10	10	0.10	10
		116,000 lb. per hr. flue gas	0.40	10	0.40		0.45	10	0.45	10	0.30	10	0.30	10
		173,000 lb. per hr. flue gas	.075	10	0.75		0.92	10	0.92	10	0.60	10	0.60	10
8.	To operate with or without economizers		With		With		With		Without		With		Without	
9.	Number of rotors per boiler unit		None		None		Two		Two		Two		Two	
10.	Price including fans and motors		.....		.....		$170,424		$170,424		$211,144		$211,144	
11.	Corrected price for three plant units without fans		$61,890		$61,890		$109,290		$109,290		$132,030		$132,030	

*Based on initial temperatures of flue gas=485 deg., 590, and 675 deg. F. respectively.

Powdered Coal Equipment

Bidder		Combustion Engineering Corporation						Fuller-Lehigh Company					
Price	Complete, with waste-heat driers and slag screens	No Bid						$293,959					
	Complete, with steam-heat driers and slag screens	$331,836 ($324,506 if screw conveyors are omitted)						$295,959					
	Complete, with waste-heat driers and without slag screens	No Bid						$267,959					
	Complete, with steam-heat driers and without slag screens	No Bid						$269,959					
	Preparation equipment with waste-heat driers	No Bid						$205,430					
	Preparation equipment with steam-heat driers	No Bid						$207,430					
	Burning equipment	$221,664						$65,709+$26,000=$91,709					
						Per Cent Tolerance						Per Cent Tolerance	
1. Delivery time, weeks		15				15		32				10	
2. Erection time, weeks		32				20		18				10	
3. Total net weight	Driers, lb.	334,400				10		120,000					
	Pulverizer mills, lb.	297,500				5		240,000					
	Feeders, lb.	124,300				5		25,200					
	Burners, lb.	75,000				5		43,200					
Motor data: constant-speed motors, 440-volt, 3-phase, 60-cycle, variable-speed motors, 220-volt, d.c.:	Service	Drive	R.p.m.	Rated Hp.	No Req'd	Total H Req'd		Drive	R.m.p.	Rated Hp.	No. Req'd	Total Hp. Req'd	
	Pulverizers	Direct connected	450	200	4	165		Direct connected	400	250	4	200	
	Pulverizer exhausters	Direct connected	1200	100	4	95		Direct connected	1200	100	4	80	
	Drier exhausters	Direct connected	900	15	4	10		Direct connected	1200	30	4	26	
	Feeder blowers	Direct connected	1800	50	6	40							
	Feeders	Silent chain	400–1600	2.5	30	2		Direct connected	600–1800	2	18	1.75*	
	Screw conveyors	Silent chain	900	20	2	12		Direct connected	900	25	2	20	
	Mill feeders							Direct connected	600–1800	2	4	1.75	
	Scales												
5. Kw.-hr. input to motors per ton of coal delivered to bunkers above boilers		15				5		17.5				10	
6. Maintenance cost of preparation plant per ton of coal delivered to bunkers above boilers		$0.05				5		$0.06				30	
7. Furnace volume per boiler, cu.ft.		12,800						13,000				10	
8. Max. coal-burning capacity per furnace lb. per hr.		23,000						23,000					
	Evaporation lb. per hr.	50,000	Per Cent Tolerance	100,000	Per Cent Tolerance	150,000	Per Cent Tolerance	50,000	Per Cent Tolerance	100,000	Per Cent Tolerance	150,000	Per Cent Tolerance
9. Combined furnace, boiler and superheater efficiency, per cent		84	..	82	..	78		84	2	81	2	78	2
10.	Coal burned, lb. per hr.	5,050	..	10,000	..	15,500		4,570	10	9,180	10	13,800	10
	Primary air supply, c.f.m. at 200 deg. F.	2,400	15	3,700	15	4,500	15	5,200	10	10,400	10	15,600	10
	Primary static pressure, inches of water	12	10	13.5	10	15	10	6	10	6	10	6	10
	Secondary air supply from heater, c.f.m. at 200 deg. F.	13,600	5	26,300	5	40,000	5	13,600	10	27,400	10	47,400	10
	Secondary air supply from boiler room, c.f.m. at 65 deg. F.	11,200	5	23,600	5	40,000	5	.....	..	.....	..	.....	..
	Secondary static pressure, inches of water	0	..	0	..	0	..	1	10	1.25	10	1.5	10
	Primary fan power, hp.	..	..	..	..	..	..	10	10	20	10	30	10
	Secondary fan power, hp.	..	..	..	..	..	..	4	10	8	10	14	10
	Feeder power, hp.	3.0	10	4.5	10	6.0	10	1.8	10	3.6	10	5.4	10

Economizers

		Power Specialty Co.		B. F. Sturtevant Co.			
				Alternate No. 1		Alternate No. 2	
	Price	$117,500		$88,476		$95,445	
			Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1.	Delivery time, weeks	26	0	18	2	18	2
2.	Erection time, weeks	12	0	10	2	10	2
3.	Net weight, lb	112,000	2	90,000	10	102,000	10
4.	Outlet temp. (deg. F.) when economizer feed inlet temp., evaporation, flue gas weight, and its inlet temp. are: 245 deg. F. 50,000 lb. per hr. 62,000 lb. per hr. 485 deg. F.	301	1	294	2 deg. F.	294	2 deg. F.
	285 deg. F. 100,000 lb. per hr. 116,000 lb. per hr. 590 deg. F.	342	1	337	4 deg. F.	337	4 deg. F.
	315 deg. F. 150,000 lb. per hr. 173,000 lb. per hr. 675 deg. F.	376	1	372	7 deg. F.	372	7 deg. F.
5.	Draft loss (inches of water) through economizer under conditions of item (4): 50,000 lb. per hr. evaporation	0.25	..	0.20	0.02 in.	0.20	0.02 in.
	100,000 lb. per hr. evaporation	0.80	..	0.78	0.05 in.	0.78	0.05 in.
	150,000 lb. per hr. evaporation	1.80	..	2.25	0.12 in.	2.25	0.12 in.
6.	Temperature (deg. F.) of gases leaving economizer under conditions of item (4): 50,000 lb. per hr. evaporation	297	..	306	6 deg. F.	306	6 deg. F.
	100,000 lb. per hr. evaporation	385	..	388	10 deg. F.	388	10 deg. F.
	150,000 lb. per hr. evaporation	453	..	448	15 deg. F.	448	15 deg. F.
7.	Water pressure drop (lb. per sq.in.) from economizer water inlet to outlet, when evaporation is: 50,000 lb. per hr.	2.50	..	2.50	0.25 lb.	2.40	0.25 lb.
	100,000 lb. per hr.	8.00	..	3.50	0.50 lb.	3.50	0.050 lb.
	150,000 lb. per hr.	19.00	..	4.50	0.75 lb.	4.40	0.75 lb.
8.	Material of tubes	Seamless Steel		Seamless Steel		Seamless Steel	
9.	Size (O. D.) and gage (B.W.G.) of tubes	2 in. No. 11 B.W.G.		2½ in.—¼ in.		2½ in.—¼ in.	
10.	Heating surface, sq.ft.	7344		5016		5016	
11.	Number of passes	One		One		Two	

Furnace Water Walls

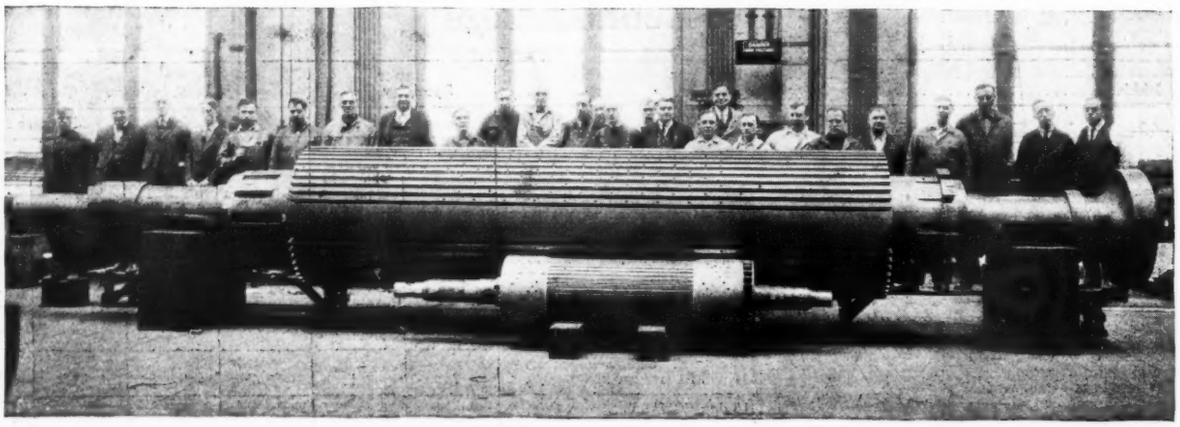
		Combustion Eng. Corp.		Power Specialty Co.		The Superheater Co.	
	Price	$148,294		$210,420		$172,000	
			Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1.	Delivery time, weeks	20	10	26	..	20	10
2.	Erection time, weeks	5	10	26	..	16	10
3.	Net weight of each furnace, side water walls, lb	50,000	10	92,500	2	47,500	10
4.	Net weight of each furnace, rear water walls, lb	22,000	10	59,000	2	16,700	10
5.	Add or deduct per sq.ft. of furnace wall surface covered, for increasing or decreasing extent of water walls: By changing number of elements	$12.50	..	$19.20	..	$5.00	..
	By changing length of elements			$9.70	..		
6.	Deduct for omitting rear furnace water walls	$45,010	..	$54,000	..	$18,000	..
7.	Furnace wall surface covered, sq.ft.	1,650		1,650		1,650	
8.	Price in accordance with specifications for 1,000 sq.ft. per boiler as included in boiler bids received July 7, 1924	$99,544		$135,540		$152,500	
9.	Surface exposed to radiant heat—per boiler	2,136		1,650		2,438	

It will be recalled that this station was first projected about three years ago, an appropriation of one million dollars having been made in June, 1922, for developing the site and preliminary engineering. This was followed in April, 1923, by a bond issue of twelve millions to complete the plant.

The initial installation will consist of three 25,000-kva. turbo-generators each served by two 9,571 sq.ft. (water-heating surface) boilers. These will have water walls and combination-type superheaters. Both economizers and air heaters are being employed, as well as powdered fuel. A working boiler pressure will be around 350 lb. per sq.in. and 200 deg. superheat. The regenerative cycle of bleeder heating will be employed.

With the various refinements enumerated, it is anticipated that the plant will show excellent performance if provided with an attractive load factor.

The new plant, which will be operated under the Public Lighting Commission, will supply the various city services including street lighting, water-works pumping, sewage pumping, fire service and public buildings. At present these services account for about 200,000,000 kw.-hr. per year. Power will be transmitted from the plant at 24,000 volts by underground cables to the switching stations from which distribution will be made to the various substations.



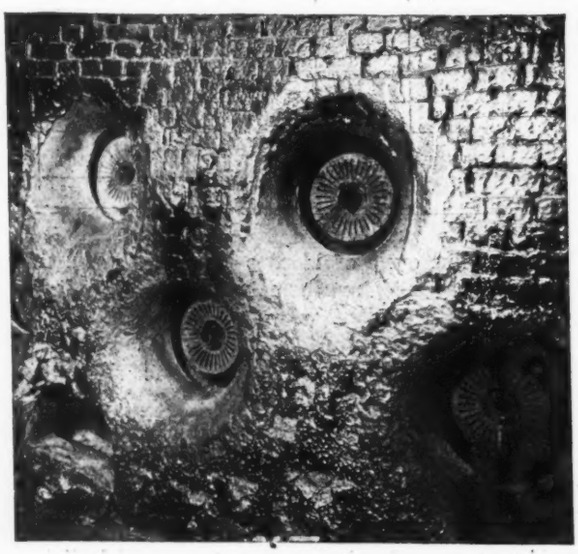
Above — Seventy-eight-ton rotor of 50,000-kw. turbo-generator being built by the General Electric Company for the Philadelphia Electric Company

This huge mass of metal will turn at the rate of 1,800 r.p.m. Ten tons of metal was removed in making the slots, which are 8 in. deep and 1¼ in. wide.

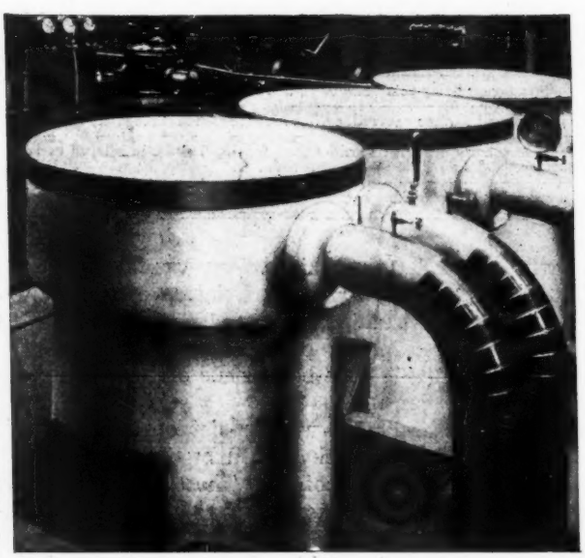
Left—Standing on the desk of A. G. Pratt, president of the Babcock & Wilcox Boiler Company, is this core removed from a 3¼-in. tube hole in the drum of the 1,200-lb. pressure boiler built for the new Weymouth Station of the Boston Edison Company

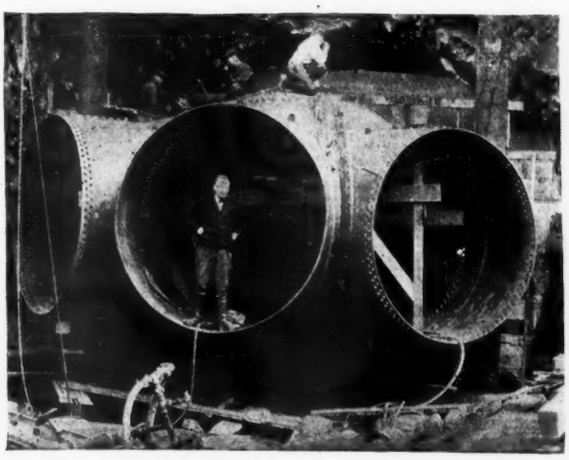
The drum, forged from a single piece of steel, weighs 92,000 lb. finished. It is 4 in. thick and 34 ft. long.

Below—Front of an oil-fired furnace of one of the forty-six boilers in the steamship "Leviathan." Note the fluxing of the firebrick which has run down over the lower part of the wall

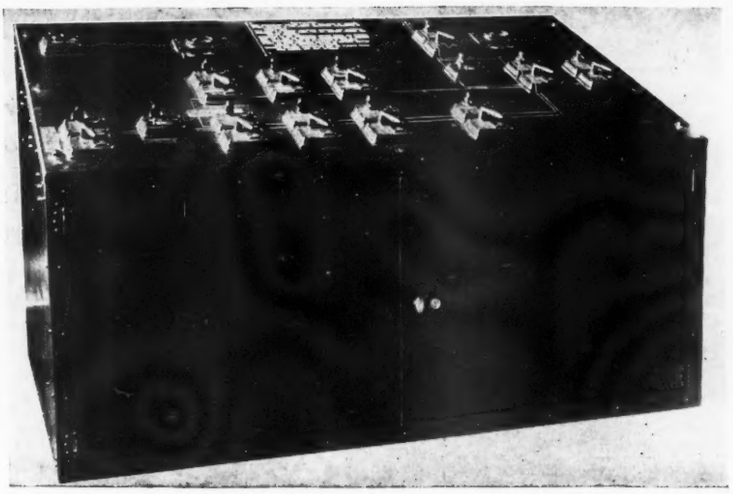


Below—Among the recent additions to the Westport Station of the Consolidated Gas & Electric Company are these novel bleeder heaters, which are of the vertical closed type





Above—Nine-foot pipe line, Oak Grove project of the Portland (Oregon) Electric Power Company



Above — Three-way steel-plate penstock manifold used on the Oak Grove project at portal of surge tunnel

Right — This benchboard, at the New Toronto (Ohio) Station of the Ohio River Edison Company, controls the entire coal-handling system

Below — The water impounded by this high overflow dam at Knoxville, Tenn., generates power for the American Zinc Company's plants

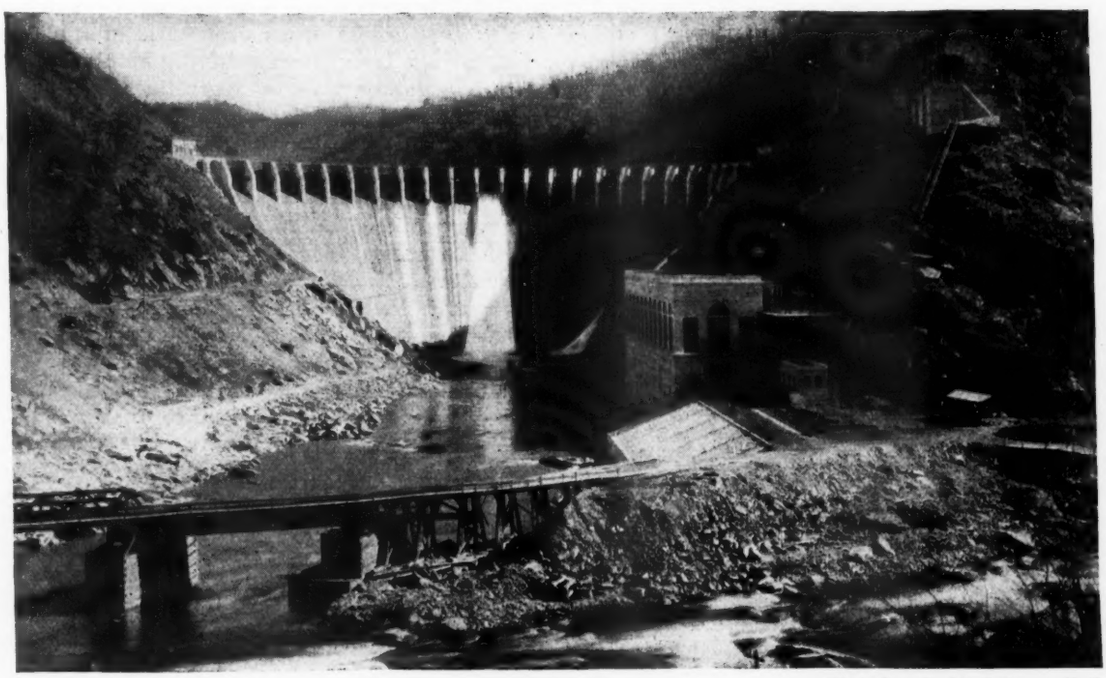


Photo from Ewing Galloway, N. Y.

Two-Speed Synchronous Motor*

Special Field-Pole Construction Allows Two-Speed Operation at High Efficiency—All That Is Necessary to Change the Speed Is a Pole-Changing Switch for the Stator and a Reversing Switch for the Field Winding

By ROBERT W. WIESEMAN
Designing Engineer, General Electric Company

THE ordinary synchronous motor is inherently a one-speed machine because its revolving field, which is excited by direct current, must rotate in exact synchronism with the rotating magnetic field of the stator. Induction motors can be built to operate at two, three, and four speeds because the induction motor has a cylindrical rotor, a uniform air gap and a distributed rotor winding. These features make it easy to change the synchronous speed by regrouping the stator and the rotor coils. In the synchronous motor with the usual salient-pole construction, the air gap is not uniform and the field winding is concentrated. Therefore, to operate a salient-pole synchronous motor from a constant-frequency supply at more than one

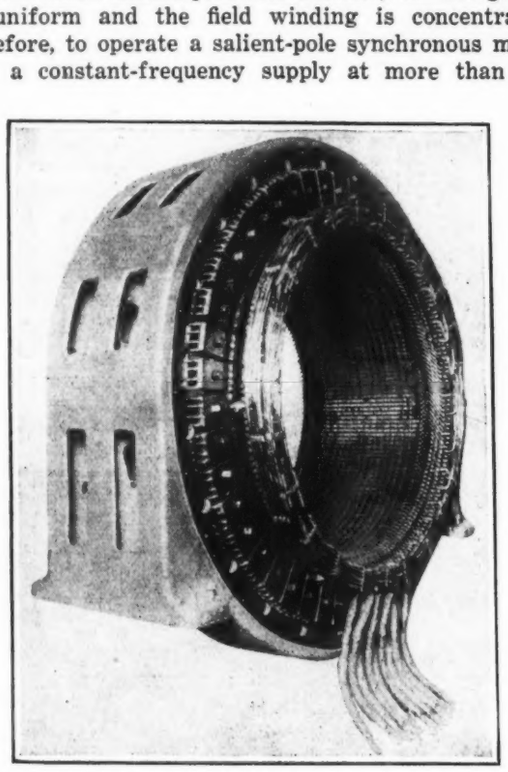


Fig. 1—Stator for 5,000- and 2,500-hp. two-speed synchronous motor

synchronous speed, a special design is necessary. Such a motor is particularly suitable for constant-torque loads because synchronous motors are most efficient when operated at normal magnetic flux and current densities at either speed.

The multi-speed synchronous motor can operate at unity power-factor, or at any desired leading power-factor, whereas the multi-speed induction motor usually has a rather low lagging power factor at the lower speed, unless a special compensating arrangement is used. It will be seen later that the particular two-speed synchronous motor described has an efficiency of

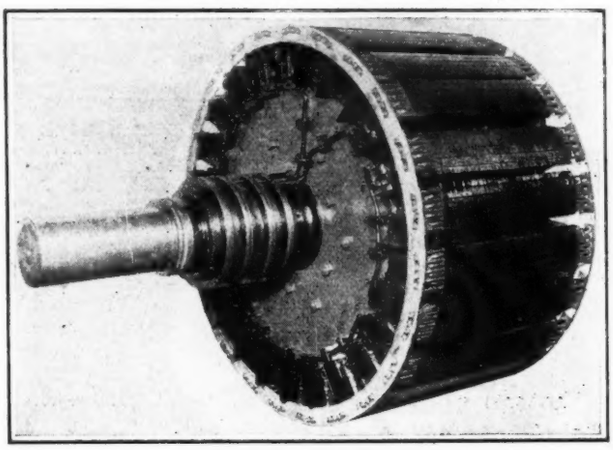


Fig. 2—Rotor for 12- and 24-pole operation at 600 and 300 r.p.m. in the stator, Fig. 1

95.6 per cent when operating at 5,000 hp., 600 r.p.m., and at 2,500 hp., 300 r.p.m. It can thus be seen that the possibility of obtaining two speeds from synchronous motors opens a new field of application which so far has been covered only by induction motors.

In order to make a synchronous motor operate at half of its normal speed, the number of poles must be doubled and the armature winding must be reconnected accordingly. Thus, to have a motor that will operate at normal and one-half normal speed, it is necessary to arrange the armature and field windings so that they can be connected for either normal or twice normal number of poles.

Fig. 1 shows the stator of a 5,000- and 2,500-hp., 600- and 300-r.p.m., 12- and 24-pole, 60-cycle, unity-power-factor, two-phase, 2,300-volt, two-speed, synchronous motor with the end shields removed. The stator winding is arranged so that a 90-deg. phase belt is obtained at both speeds.

Fig. 2 shows the rotor completely assembled. The poles are equally spaced so that the maximum amount of interpolar space can be utilized for the field coils. This motor is used on a 24,000-kva. frequency converter set where it was desirable to place the motor coupling between the rotor and the bearing. In order to reduce the axial length of the set to a minimum, all four collector rings were placed at one end of the rotor. The usual practice is to place the coupling

*Abstract of a paper presented at the Spring Convention of the American Institute of Electrical Engineers, St. Louis, Mo., April 13 to 17, 1925.

beyond the bearing, and then it is desirable to place two collector rings on each side of the rotor.

Fig. 3 gives a section view of the motor showing the unsymmetrical pole tip. The poles are equipped with an amortisseur starting winding, consisting of five bars per pole. Starting tests show that the unsymmetrical pole face has no tendency to cause the motor to lock at a sub-synchronous speed when it is connected for either speed.

An interesting feature in the rotor construction of this two-speed motor is the possibility of arranging the field coils at the high-speed connection to form a two-phase winding which would give considerable starting torque when the motor is operated as an induction motor. This can be done by dividing the coils into two independent groups, each group consisting of alternate coils connected in series and by short-circuiting the groups separately. The disadvantage of this scheme is that eight collector rings would be required and thus the axial length of the motor would be increased.

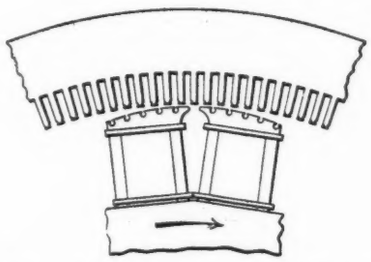


Fig. 3—Shows special field-pole construction

Scheme for Changing the Number of Rotor Poles

The scheme for changing the number of effective rotor poles in the ratio of two to one is shown by Fig. 4. The polarity of the polar projections for the high speed is indicated by *N, S, S, N,* etc., to the right of the vertical center line, and the polarity for the low speed is indicated by *N, S, N, S,* etc., to the left of the vertical center line. To simplify the method of connecting the field coils, half of the coils have their connections made on one end of the rotor and the other half are connected on the opposite end. It should be noted that every other pair of polar projections have the same polarity for both the high- and low-speed conditions and the field coils in these polar projections are connected to one set of collector rings—to the right. The pairs of polar projections whose polarities must be reversed when changing from the high to the low speed, or vice versa, are connected to the other set of collector rings—to the left. The two sets of collector rings are connected in series through a reversing switch. The number of rotor poles is changed in the ratio one to two—high to low speed, or vice versa—by throwing the reversing switch up or down.

The stator of the two-speed synchronous motor is practically the same as for the single-speed type. The stator frame and punchings are exactly the same. No special arrangements of the turns or the conductors in the coils are necessary. The only difference is in the stator coils and coil connections. The coils usually have a smaller pitch than those used on ordinary synchronous machines, and thus the coil end projection is less. The stator-coil pitch can be varied within certain limits to accommodate the conditions of design. At the high-speed connection the coil pitch can be made 50 to 60 per cent, which makes the pitch 100 to 120 per cent at the low-speed connection.

Alternating-current motors are usually supplied with electric power from constant potential lines. Since it is desirable to have the magnetic flux density in the air gap approximately the same at both speeds, it follows that the number of turns in series per phase of the stator winding at low speed must be twice the number in series at high speed. Therefore, changing the number of stator poles in the ratio of one to two consists of changing the number of circuits in the ratio of two to one in such a manner that half of the phase groups are reversed. The method of reconnecting one phase of the stator winding by reversing every other phase group is similar to reconnecting the field coils as shown by Fig. 4.

Starting Current and Starting Torque on High and Low Speed

Figs. 5 and 6 give the starting torque and starting current for the low- and high-speed conditions respectively. A comparison of these figures shows that the starting torque developed with the high-speed connection is much higher than that developed under the low-speed condition. The flux density in the air gap is higher and the reactance is lower for the high-speed condition and since the torque varies approximately as the square of the flux density and inversely as the reactance, it follows that the high-speed condition should give a higher starting torque.

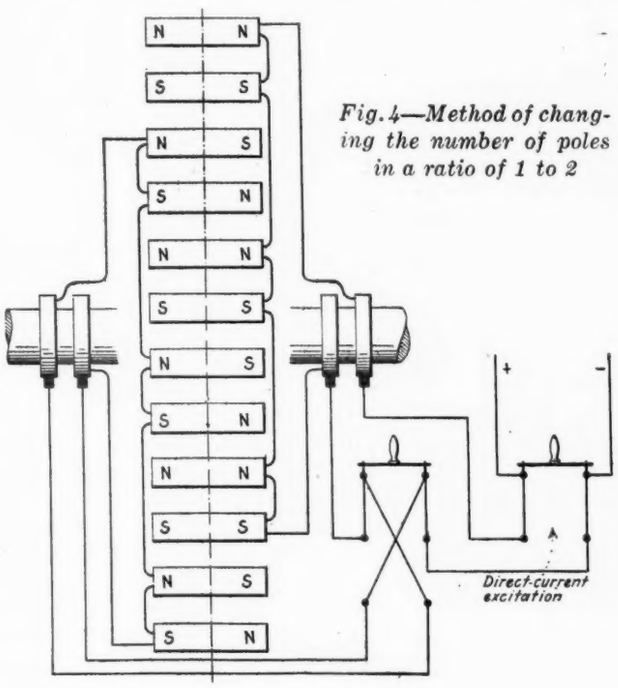


Fig. 4—Method of changing the number of poles in a ratio of 1 to 2

The efficiency curves of this motor at the high and low speeds are shown in Fig. 7. These efficiencies were obtained experimentally by the segregated-loss method, and they include the windage and friction loss, open-circuit core loss, short-circuit core loss, armature and field I^2R losses. These efficiency curves show that at normal load the efficiency is about the same at both speeds. This refers to 5,000 hp., 600 r.p.m. and 2,500 hp., 300 r.p.m. The stator I^2R losses are about the same in either case, but the windage and core losses are much less at the low speed. This accounts for the high efficiency at the low speed.

The efficiency of this machine obtained by test, when used as a multi-frequency generator, is as follows:

300 Revolutions per Minute	
12 poles 30 cycles	24 poles 60 cycles
2,000 kw., 1.0 p. f.	2,000 kw., 1.0 p. f.
Efficiency 95.4 per cent	95.6 per cent
600 Revolutions per Minute	
12 poles 60 cycles	24 poles 120 cycles
4,000 kw., 1.0 p. f.	4,000 kw., 1.0 p. f.
Efficiency 95.7 per cent	95.8 per cent.

The efficiency at 300 r.p.m., 60 cycles is slightly higher than at 300 r.p.m., 30 cycles because the field I^2R loss is less for the 24-pole connection.

This particular motor was built to drive an alternating-current generator at two speeds in order to obtain two frequencies, but can function equally well as a two-frequency generator when driven at constant speed, as shown in the preceding paragraph. Thus a frequency converter set, consisting of two of these machines, could supply three different frequencies.

Possible Uses for the New Type Machine

In the past in some mine-fan installations, where the full capacity of the fan was not required at certain intervals, two synchronous motors were coupled to each fan to obtain two-speed operation. In cases where a speed ratio of one to two is satisfactory, the two-speed synchronous motor should be suitable. Although this load would not be a constant-torque load, the efficiency at both speeds could probably be made higher than that of a corresponding two-speed induction motor. Furthermore, the synchronous motor can be operated at any power factor to obtain power-factor correction. One difficulty in this application is that 100 per cent pull-in torque is required, which necessitates a heavy starting

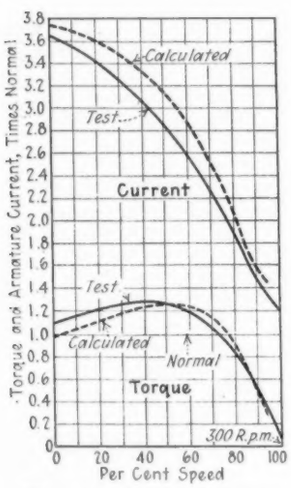


Fig. 5—Starting-torque and current curves for 300-r.p.m. connection on normal voltage

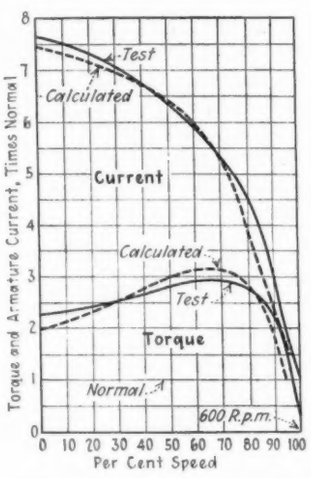


Fig. 6—Starting-torque and current curves for 600-r.p.m. connection on normal voltage

winding. The ordinary starting winding can be used if a clutch is installed or if the motor is equipped with a rotating frame (super-synchronous motor).

Synchronous motors are now being used for ship propulsion. Changes in motor speed are accomplished by changing the generator frequency by varying the turbine speed. With a two-speed motor half-speed can be obtained at normal frequency. The advantage of this scheme lies in the operation of the steam turbine at normal speed where the efficiency is maximum.

Backwater conditions at certain water-power plants are such that the effective head is much less (sometimes one-half) during the rainy season than during the dry season. For efficient operation, the waterwheel speed should be reduced with the head, a condition that gives a much lower turbine speed during the rainy season. Where the turbine speed is reduced to

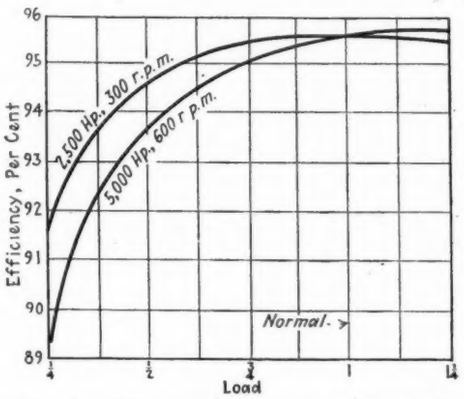


Fig. 7—Efficiency curves at 600 and 300 revolutions per minute

one-half, a two-speed generator would give normal frequency at both normal and one-half normal speed of turbine.

Uses of Motor on Compressors

It was originally hoped that the two-speed synchronous motor could be used advantageously for refrigeration. In the summer the ammonia compressors are usually worked continuously at full capacity. In the winter the compressors are underloaded. In some cases two-cylinder compressors are operated with only one cylinder, a condition requiring abnormally large flywheels. Otherwise trouble due to hunting and excessive current pulsations will be experienced. This difficulty is now being overcome by using the modern clearance pockets in the cylinder of the compressor. With a two-speed motor both cylinders could be used at one-half speed, which would give the same degree of refrigeration as at full speed with only one cylinder; but about five times the normal-speed flywheel effect is necessary to prevent excessive current pulsations. Thus the flywheel for this condition is nearly as large as the one required when the compressor is underloaded, and the advantage of the two-speed synchronous motor in this case is not so marked.

There is nothing special or complicated about the construction of the two-speed synchronous motor. Its performance can be predetermined with the same degree of accuracy as that of the ordinary synchronous motor. It does not require any more attention than an ordinary synchronous machine, and its maintenance expense is the same. The cost of such a motor is only slightly higher than that of an ordinary synchronous motor whose rating is equal to the low-speed rating of the two-speed motor. Therefore, this new synchronous motor is a practical machine and should open a new field for synchronous-motor application.

The problem of separating pure oxygen from the air has been solved in the construction of apparatus that first liquefies the air and then allows the nitrogen content to gasify or boil away, leaving the oxygen.

Oil Engines in Plants Requiring Steam

By L. H. MORRISON

THE majority of the technical and engineering societies have set apart the week of April 20 to 25 as Oil and Gas Power Week, during which over 150 meetings will be held throughout the country to discuss the more economical use of our petroleum resources. In view of the widespread interest in this movement a typical Diesel power plant has been designed and appears in the special insert of this issue.

EXAMINATION of the power plants in the states west of the Mississippi River and east of the Rocky Mountains reveals that a large number are equipped with internal-combustion engines. Two factors have caused this shift from steam power. In the first place oil is available at low prices, and in addition most of the plants have little need of steam for heating or process work due to the character of the plant; in fact, the central stations represent a goodly percentage of the plants.

In the Eastern States, or at least in those north of the Mason-Dixon line, an entirely different condition prevails. Steam is needed for heating during from five to seven months of the year, while many of these industrial plants are called upon to supply either process hot water or steam.

With respect to the industrial plant there is seemingly a tradition that the need of steam or hot water at once precludes the Diesel from consideration. This is far from being accurate as to the possibilities of using oil engines in such industrial plants.

In making this study the industrial plants may well be classed as follows:

A. Plants requiring high-pressure steam.
B. Plants where the entire engine exhaust is used.
C. Plants where only a part of the exhaust is used.
D. Plants using exhaust for processing and heating.
E. Plants using all the exhaust for heating only.
F. Plants using a part of the exhaust for heating in winter, followed in summer by (1) Non-condensing operation, (2) condensing operation.
G. Plants purchasing electrical energy, but using steam generated in: (1) Boiler using fuel; (2) Electrical boiler.

Taking up Class A, one should first observe that seldom is high-pressure steam actually required, although many textile mills are so operated to a decided detriment in efficiency. However, assuming high-pressure steam be needed, the power-generating plant is at once divorced from the processing, in so far as the kind of engine to be used. Consequently, it becomes a mere matter of cost of operating a steam plant *versus* the cost with oil engines. Even though condensing water be available, only in exceptional cases will the cost of steam operation equal the Diesel plant costs. Broadly speaking, plants of less than 3,000 kw. seldom do better than 4 lb. of coal per kilowatt-hour, and the range is upward to 10 lb. per kw.-hr. With coal at $5 a ton the fuel cost will not be lower than 1 cent per kilowatt-hour. The oil engine will deliver 10 kw.-hr. per gal. of fuel, which at 5 cents represents a fuel charge of one-half a cent.

In a preliminary estimate, then, we may say that for the fuel cost in the steam plant to equal that of the oil engine the cost of coal per ton in dollars must be one-half the cost of oil in cents per gallon, which is an infrequent condition. Labor in the steam plant will be as large an item as in the oil-engine plant without considering the force in the boiler room. Repairs will be somewhat on a parity, and overhead in case of a modern steam plant will equal the overhead of the Diesel plant, for a modern steam plant of under 3,000 kw. will cost around $150 per kilowatt capacity, and this is above the approximate cost of the oil-engine plant.

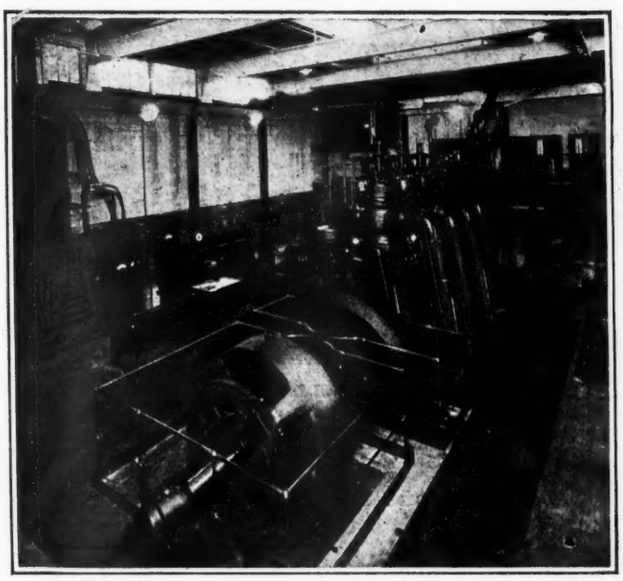


Fig. 1—Publishing plant where Diesel and steam engines are used

As to Class B plants, obviously, if all the exhaust steam is used, the steam engine is the more efficient prime mover since power is being generated at a very low heat consumption. No internal-combustion engine can approach the efficiency of such a plant.

One point, however, must be emphasized—many industrial plants, while using all the exhaust during the entire year, actually can be satisfactorily served by a far less amount of steam. By suitable and intelligent rearrangement and supervision of the low-pressure steam equipment the use of heat may be reduced as much as one-half. Nevertheless, in winter steam heating is required, which by rearrangement may be accomplished with part of the engine exhaust, the remainder going to the processes. This brings us directly to a situation when during the non-heating season the

engine room is passing part of the exhaust steam to the atmosphere, which places the plant in Class C or Class D.

The majority of industrial and building plants have no, or but a meager, use for exhaust steam save for heating. The Class E plants are assumed to use all of it in this way, but this can only occur on the coldest days of winter. For the rest of the year a part, the extent of which depends upon the outside temperature, must be wasted through the atmospheric line. While, during the cold days, the efficiency of the plant is extremely high, this is offset by the extremely low efficiency during the rest of the year.

For example, consider an industrial plant having 1,000 kw. in generating units with a water rate of 35

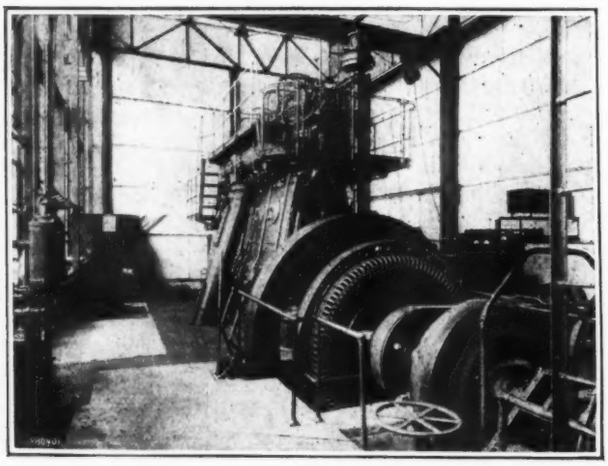


Fig. 2—Cotton-seed mill uses Diesel for power and steam for processing

lb. per kw.-hr. and using all the exhaust during the winter at 2 lb. gage.

If the desirable room temperature be 70 deg. and the coldest weather, of 10 deg. F., occurs during January, we have a total hourly heating load equivalent to 35,000 lb., or approximately 350,000 lb. per 10-hour day, ignoring for the moment the heat required to warm the factory in the mornings and the heat abstracted by the generating units.

For the purposes of the problem it may well be assumed that, taking 70 deg. as the desirable shop temperature, the difference between outside temperature and 70 deg. supplies data for the computation of the amount of heat needed per month.

While it is sometimes assumed for convenience that an engine, when connected to a heating system, produces power at practically no cost, it is well to bear in mind that the engine does abstract heat from the steam. For each kilowatt-hour developed 3,415 B.t.u. is used and is unavailable to the heating system. With a water rate of 35 lb. per kw.-hr., out of each lb. of steam 97.6 B.t.u., or in round numbers 100 B.t.u., does not enter the heating system. With an initial pressure of 150 lb. gage and a condensate or heating return temperature of 150 deg., to each lb. of steam there is added in the boiler 1,075 B.t.u.; of this 100 B.t.u. is converted in the engine. In other words, 9.3 per cent of the coal bill should be charged against the engine even though all the exhaust be used.

This indicates that power is not obtained at zero cost at any time and that during January the heating system does not receive the heat equivalent of 10,500,000 lb., but 9.3 per cent less than that amount. Continuation of this for several months gives a tabulation of the pounds of steam needed for heating, as shown in Table I.

It is apparent from this tabulation that the heating system takes but 47,620,500 lb. of a total passing through the engine of 126,000,000 lb. per year.

In industrial plants where hand firing is followed, an evaporation of 7½ lb. of steam per pound of coal is fair

TABLE I—STEAM USED BY HEATING SYSTEM

Month	Outside Temp., Deg. F.	Lb. Steam for Month	Month	Outside Temp., Deg. F.	Lb. Steam for Month
October	50	3,175,500	April	40	4,761,750
November	40	4,761,750	May	50	3,175,500
December	20	7,936,250	June	..	.....
January	10	9,523,500	July	..	.....
February	20	7,936,250	August	..	.....
March	30	6,349,000	September	..	.....
Total lb. steam					47,620,500

and will be used in determining the power costs. Taking the values in Table I, the coal chargeable to the engine will work out as shown in the last column of Table II.

For a total yearly load of 3,600,000 kw.-hr., the coal consumption is 5,231 tons, or at the rate of almost 3 lb. per kw.-hr., and with coal at $6 per ton represents an outlay for power of $31,386, and for heating of 3,174.5 tons costing $19,047.

It is known that when the engine load balances the heating demands, the thermal efficiency of the generating units is high, roughly that of the boilers, but this is largely offset by the operation during the non-heating systems. One solution would be to arrange the engine to operate condensing during the summer. This involves the problem of a cooling-water supply and a considerable investment in condensing equipment. In addition, the net saving by operating condensing from May 30 to Sept. 30 would not exceed 15 per cent of the coal, partly offset by the increase in overhead. A

TABLE II—FUEL CONSUMPTION OF STEAM PLANT AND OF COMBINED STEAM AND OIL ENGINE PLANT

Month	Steam Units: Kw.-Hr. Output	Steam Units: Coal, Tons	Diesel Units: Kw.-Hr. Output	Diesel Units: Oil, Gal.	Heating System, Coal, Tons	With Steam Engines Exclusively Coal, Tons
January	300,000	65	0	0	635	65
February	250,000	54	50,000	5,000	529	171
March	200,000	43.4	100,000	10,000	425	277
April	150,000	32.6	130,000	15,000	317	382
May	100,000	21.7	200,000	20,000	211.7	489
June	.....	.....	300,000	30,000	.....	700
July	.....	.....	300,000	30,000	.....	700
August	.....	.....	300,000	30,000	.....	700
September	.....	.....	300,000	30,000	.....	700
October	100,000	21.7	200,000	20,000	211.7	489
November	130,000	32.6	150,000	13,000	317	387
December	250,000	34	30,000	3,000	529	171
Total*	1,500,000	325	2,100,000	210,000	3,175.4	5,431
Cost		$1,950		$10,500	$19,154	$32,586

* Coal at $6 per ton, oil at 5c. per gal.

second plan would be to operate at low heating-main pressures with a condenser to handle the excess steam. This involves a complete revamping of the heating system, and the results seldom would justify the expense.

Suppose in the industrial plant problem just outlined, that one or two Diesel engines of a total of 1,000 kw. be installed alongside the present steam units. What influence would it have on the cost of power?

If the load on the steam engines be just enough to give an amount of exhaust steam for the heating requirements, the steam-engine portion of the plant would be delivering a kilowatt-hour at the expenditure of but 0.3 lb. coal. The remainder of the power load

would then be carried by the oil-engine units at a consumption of 0.75 lb. of oil, or approximately $\frac{1}{10}$ gal., per kw-hr. As the heating demands lessened, a greater part of the load would be assumed by the Diesels until during the summer the steam plant could be closed down. A tabulation of the monthly operating costs is of interest and is given in Table II.

In the combined plant the steam-generated energy will have a total yearly fuel cost of $1,950, or a trifle more than 1 mill per kw.-hr., the Diesel units will consume 220,000 gal. of oil, costing, at 5c. per gal., $10,500, while the heating plant will use $19,054 in coal. The total fuel bill will amount to $31,504, which gives a saving of $20,136 over straight steam operation.

In view of the fact that a Diesel plant of 1,000 kw. can be and has been installed for less than $125,000, it is not difficult to determine the economic advantage of the combined plant. Overhead charges, in view of the accepted Diesel life of 25 years, and calculating interest on a diminishing capital, is 10 per cent, or $12,500 per year. Deducting this from the operating saving gives a net advantage of $8,000 per year.

So far the assumption has been that the plant operates only 10 hours a day. In many industries the hours of operation are 16, covering two 8-hour shifts. Under such conditions the advantages of a combined plant become still more attractive. If the heating load remains fairly constant over the two shifts, the yearly fuel costs become: Steam-generating units, $3,072; heating, $30,483; Diesel fuel, $16,080—making a total of $47,635, which gives a net profit of $43,000 over straight steam operation, or about 33 per cent on the Diesel plant investment.

It has been claimed that even in winter the heating load did not coincide with the power demands, causing much live steam to be used in heating and likewise large amounts of exhaust steam to be wasted through the atmospheric relief valves. As a consequence often it has proved more economical to purchase the power and heat with live steam. The combined plant serves to rectify this trouble, and the balanced plant will supply power at a low rate. In the 16-hour day factory the fuel for power has been shown to cost $19,152, or $3\frac{1}{2}$ mills per kilowatt-hour.

Lubricating-oil consumption will average 1 gal. per 1,000 kw.-hr., or $\frac{6}{10}$ mills. Repairs will average over the engine life, 2 per cent of the investment. On a basis of $125,000 for the Diesel units and $60,000 for the steam units this works out as $\frac{6}{10}$ mills per kilowatt-hour. The main operating items are then: Fuel, mills, 2.6; labor, 0.6; repairs, 0.6; waste, etc., 0.2; total per kw.-hr., mills, 3.

Overhead on a diminishing instrument and a life of 25 years will, with the usual interest rates, be 10 per cent, or 3.2 mills per kilowatt-hour, making a total cost of 6.2 mills per kilowatt-hour—much less than the cost of purchased power. On the other hand, the non-condensing steam plant would have an operating cost much higher and in many cases above the cost of purchased current.

Some may raise the objection to the combination plant that the capital investment is high. This is concededly true, but the return on the investment is far greater than in usual business ventures. It is possible to reduce the investment by an elimination of the steam engines. This sounds radical in view of the obvious fact that the heat necessary to develop the mechanical power is obtained at 100 per cent efficiency. Still the steam units may be eliminated without a decrease in operating efficiency.

This is for the reason that in the usual industrial plant boiler efficiencies are seldom higher than 70 per cent for daily operation. There is, then, an immediate loss of 30 per cent, of which the heating system and steam and steam engines must bear their proportional shares. By proper waste-heat recovery the Diesel engine will show a thermal efficiency of over 75 per cent. Provided the heating system can be operated with hot water rather than steam, it is just as efficient to use the Diesel hot water as it is to heat it in a boiler. The capital investment in the power plant would drop somewhat from that used in the study.

All industrial plants are not adapted to the combination steam oil engine room, but in hundreds of factories such an installation would be decidedly profitable, and engineers should see if the plan is adaptable to the plants in their charge.

Inspection of Hydraulic Elevators

By Warren Hilleary*

Piston rods on hydraulic-elevator engines have been known to break off in and just above the piston, having become weakened through pitting. There is a divided opinion as to how often the top head of the cylinder should be taken off for rod inspection. The material in the rods, their cross-sectional area, the load on them and the nature of the water govern to some extent the frequency of inspection. Five years is a maximum period to allow between inspections, and inspection every two years is desirable.

Inspection of the hoisting cables on vertical hydraulics is difficult and not infrequently dangerous. This makes it especially necessary that every square inch of the cable surface should be carefully examined, for the greater the difficulty in inspecting cables the greater the liability of overlooking defects.

Cables to be Examined

There are hoisting, operating, automatic stop, governor and in some cases, car counterweight cables, to be examined. The hoisting and car counterweight cables and the operating cables on such types as have the running rope system can best be examined by moving the car three or four feet, stopping it, and examining three or four feet of the cable, repeating the process until the full length of each cable has been examined. Where the tilting sheaves are mounted on the car bottom, the operating cables can best be examined from the top of the car by having the car run from the top to the bottom, very slowly. The parts of the cables which travel over or under guiding sheaves in the top and bottom of the shaft are difficult to examine because portions of them are concealed by sheaves, and because of the accumulation of oil and dirt which is generally found on them. Operating cables wear and break more rapidly, as a rule, where they pass over or under the small sheaves in the bottom of the shaft, and in the head gear, than they do along the length covered by the tilting sheaves. It follows that they need very careful inspection at these points. Governor and auto-

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matic stop cables are also difficult to examine, for the same reasons.

Lever latches are provided on hydraulic elevator cars, but the attendants frequently remove the latch or tie it up. Inspectors should see that the car stands still at any floor (other than the terminal floors) when the position occupied by the latch is directly over the latch notch. If the car does not stand, ascertain whether there is any position of the lever at which it will, and if it is found to stand when the lever is off the center of the notch, it is an indication that the turnbuckle on the reach rod under the car needs adjusting or that one operating cable needs shortening.

It is never advisable to start a hydraulic elevator, after the supply line valve has been closed for some hours, without first relieving the cylinder and valve chambers of the air that will likely have accumulated in them. Air in the cylinder constitutes a dangerous condition on account of its great compressibility and the fact that the main valve will not properly control nor be controlled by air. Means are provided in the top of the cylinder and in the top of the circulating pipe and generally in the main valve body, to relieve the air.

The condition of the bushings in the traveling crosshead sheaves, and the shafts upon which they revolve, cannot readily be determined except when the cables are off the sheaves.

Give Cable Guards Attention

Cable guards, wherever found, are liable, at times, to get badly out of adjustment; also, they are often taken off during repairs and not replaced. Any missing ones must be put on at once, and any out of adjustment must be adjusted. Without the guards cables are certain to get off the sheaves, the result generally being a cut or broken cable or a breakage of some part of the equipment.

There must be two tappets, touching, on the automatic stop cable, at both the top and bottom terminal positions. A single tappet may slip or break, thus rendering the stop useless at one terminal.

The external part of the automatic stop-valve gear, will often be found in need of repair. The weight lever may be loose on its flanged sheaves, the gear may not be meshing properly with its pinion, the cast-iron guard over the gears may be loose, the clamps securing the stop cable to the flanged sheave may be loose; the stop cable, owing to an unnecessary amount of slack, may be crossed on the sheave, the gear may be loose on its shaft, or the shaft mounting may be loose. These defects the inspector can see by watching the action of the stop device.

All hydraulic stop valves should be of the gate type and bypassed. Without the bypass the valve, if 4 in. or over, cannot be opened or closed with any degree of ease, speed or certainty, and disks, seats and threads wear badly.

Stopping Car at Terminal Landings

When the car strikes the hand-rope tappet at terminals, the valve is often caused to travel to the reverse position, and this is dangerous. To prevent reversal, the cable must be tightened much more than is good for the whole moving apparatus. Sometimes a coil spring and soft rubber washer, placed on the car and engaging the tappets, will suffice. The spring must be carefully designed to prevent its doing the reversing which it is intended to prevent. If it is too long, too large and too open, it will throw the tappet and cause reversal of the valve. Wooden guides and corrugated jaw safeties almost invariably follow the hand-rope control. Great care must be exercised in setting the safety not to allow the corrugations to mar the surface of the guide rails. If they do the jaws are certain to catch in the sliver or notch, when the car is running down, and damage the guide rail. Very often the jaws will be so out of adjustment that they cannot reach the guides when they are moved to their extreme of inward travel. The rod connecting the two jaws will be found to have a coil spring placed upon it, the purpose of which is to hold them in their off position. Unless this spring is in good order and adjusted, the jaws may, through jarring of the car in normal travel, reach the guides, cut them badly and stop the car.

The rack and pinion valve gear accompanies the hand rope control, and this gear, together with the large flanged sheave for the hand cable, will generally be found in need of considerable repair. The nature of the repairs will be evident at a glance when the car is in normal use.

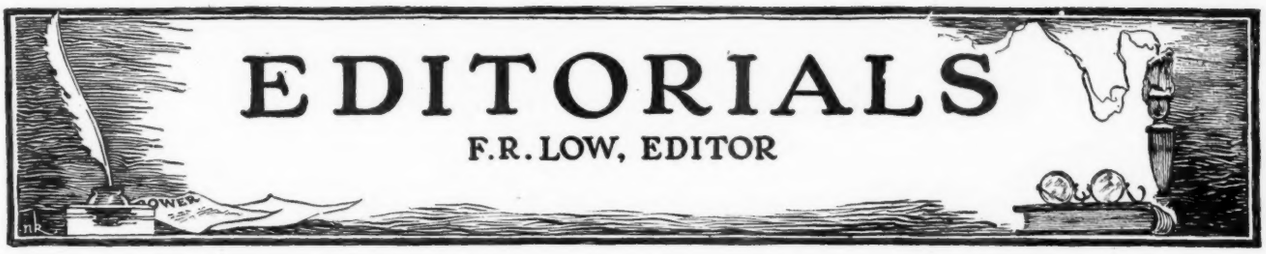
There should be, and generally is, a strainer on the supply line from the pressure tank to the pilot valve. This strainer is intended to prevent particles of packing, waste, etc., from getting into and clogging the pilot-valve ports. As these strainers become filled with accumulation, the water passage is obstructed, and the main valve slows down. Instead of cleaning the strainer, the attendant is likely to open the adjusting valve on the line to the pilot valve in order to get the usual speed on the main valve. Then, when the strainer is finally cleaned, the volume of water to the main valve is so great as to cause it to operate so fast that the operator cannot make safe stops.

Location of Discharge Pipe

The discharge pipes from any type of hydraulic elevator should discharge below the water line in the surge tank, for by so doing the water in the tank is less agitated than when the discharge is above the surface, and the less the agitation the less will be the quantity of air carried into the suction pipe of the pump, and the less will be the back pressure against the discharge.

It is advisable to keep the gage-glass valves closed, except in those cases where an attendant is always present in the vicinity of a tank. Where the attendant is away for some time, making repairs to equipment throughout the building in which the elevators are located, and should the glass break, which is not an infrequent occurrence, considerable damage may be done by escaping water, and a considerable amount of air will also be lost. Gage glasses are likely to break when the valves are opened, and the attendant should exercise care to be in such position when opening the valves, that flying particles of glass will not strike his face.

Some engineers consider it desirable that a pressure gage connected to the pressure tank should be located at some point in the shaftway where the operators of the cars can, when the elevators are at the ground floor, determine the pressure on the system and thus not attempt to make a trip when the pressure is below a certain point. Undoubtedly, such an arrangement has its value, for if the normal running pressure is, say, 150 lb., and for some reason the pressure drops to 100 or 125 lb., it is not desirable to attempt to make an upward trip with the car until the pressure again is raised to 130 or 140 pounds.



Efficiency and High Furnace Temperature

HIGH over-all boiler efficiency has been so generally associated with high furnace temperatures that the latter have frequently been pictured as fundamentally necessary to high efficiency. Such is not the case, in theory at least.

Concentrating on the flue loss in sensible heat, two things only can save fuel. One is a reduction in the weight of flue gas produced per pound of coal. The other is a reduction in flue temperature. Low flue loss is not caused by a high furnace temperature. Rather are both of these results of the same cause, plus certain additional causes which apply to one and not to the other. Low excess air is one cause of low flue loss, in that it reduces the weight of flue gas per pound of coal burned and generally reduces the flue temperature as well. While low excess air tends to increase the furnace temperature at the same time, other factors tending to lower the furnace temperature may be in operation without causing any loss in efficiency. There seems to be no logical reason why reduction of furnace temperature by unusual exposure of water-heating surfaces, for example, should reduce the efficiency in the slightest, provided this temperature reduction is not carried to the point where it results in incomplete combustion of solids or gases. In fact, granting this limitation, it is self-evident that any reduction in furnace temperature that can be accomplished without increasing the excess air should result in slightly lower flue temperatures and hence in slightly higher over-all efficiencies.

In calling attention to this fact that high furnace temperature is a result rather than a cause, it is not intended to minimize the value of using variations of furnace temperature as a rough measure of efficiency for any given boiler set-up.

The Sesqui-Centennial Gets a Fresh Start

TO COMMEMORATE the one hundred and fiftieth anniversary of that most significant fact in American annals, the signing of the Declaration of Independence, some noteworthy citizens of Philadelphia started plans in 1920 for a Sesqui-Centennial celebration that would be worthy of the event and would rival the Centennial of 1876.

Great enthusiasm was manifest, committees were formed, the legislature of Pennsylvania indorsed the project in 1921, and President Harding in a special message to Congress voiced the approval of the nation. The committees of the Engineers' Club of Philadelphia mapped out a wonderful and beautiful plan for an exhibition that would be of international magnitude.

Politics and selfish interests killed these plans.

Now, however, there is to be a fresh start. A celebration is announced for 1926, even though its magnitude and scope will necessarily be curtailed greatly. The plans include an exposition.

With the limited time for preparation and the great haste that must of necessity be made, sight should not be lost of the fundamental objects of this celebration.

The Centennial, with its great display of machinery—the Corliss engine in the huge Machinery Hall—was a sight every visitor remembered for the remainder of his life. It was a record of the progress of the new country, a stock taking of its mechanical genius as well as its political experiment.

In the fifty years that have passed since that event in 1876, greater progress has been made in the generation and application of power than was dreamed of at that time. Today our whole civilization, our social and industrial life are dependent on it. The exposition would fail in one of its prime essentials if it did not portray this progress.

Extending the Use Of Synchronous Motors

ONE of the outstanding developments in the electrical industry has been the synchronous motor. Starting in the early days of the industry with a bad reputation, which was to a large degree justified, it has been developed into a machine that has a wide range of satisfactory applications, and each year sees this range extended. With the earlier type of motor means were provided for bringing it up to speed without load and synchronizing it with the line in much the same way that an alternator is put into service. After the motor was connected to the line, the load was applied through a clutch or other device. If everything was favorable, the operation was fairly satisfactory, otherwise there was likely to develop a bad case of hunting.

But all this is past history, and today, if the application warrants such a machine, a synchronous motor can be had that will develop a starting and pull-in torque equal to its pull-out torque. Modern synchronous motors are applied as readily to applications requiring automatic control as simple induction motors. They have been applied to driving steel rolling mills, which is considered one of the most difficult drives. In certain applications, such as for driving large compressors, the synchronous motor has come to have practically a monopoly.

This type, like the induction motor, is inherently a constant-speed machine. The induction motor has been used as a multi-speed machine by changing the grouping of the windings for a different number of poles. The distributed type of windings used in these machines lent themselves to such applications. On account of the salient-pole construction of the synchronous motor it has not been readily adapted to a change in the number

of poles. Recent developments, however, have made this possible, as described in the article, "Two-Speed Synchronous Motor," in this issue. This change in speed has been accomplished without sacrificing any of the desirable characteristics of the single-speed machine and at little increase in cost. Although it is too early to predict the possibilities of the new motor except in a general way, this new development will undoubtedly have a healthy effect in extending the synchronous motor with its desirable power-factor characteristics to new applications.

Limiting Possibilities In Steam Plants

AMERICAN engineers since the war have given a great deal of study to higher pressures and temperatures in steam plants. Rapid developments have already been made, and reductions in the coal consumption as a result of higher station economy have practically offset the rising prices of coal. The possible steam cycles and efficiencies have been discussed in papers before the A. S. M. E. by Orrok, Helander, Hirshfeld and Ellenwood, and Wohlenberg.

Recent issues of a British contemporary, *Engineering*, have contained a paper on this subject by Drs. Mellanby and Kerr, of Glasgow, which deserves more than passing interest. The authors have analyzed the power plant from a theoretical and also from a practical viewpoint. In connection with the practical aspects they have not confined themselves to past practice, but have stated certain things that they consider quite practicable at our present state of knowledge, although not now applied.

Their analyses lead them to the conclusion that the most economical pressure will be 1,250 pounds with two stages of reheating at 500 and 180 pounds per square inch. The 1,200-pound unit at Weymouth is almost ready for operation, so this limit is not beyond present practice. It is proposed by the authors to bleed steam at eight points to heat the feed water up to 545 degrees F. This also is quite feasible and will undoubtedly be adopted whenever it can be shown that the savings over a fewer number of bleeder heaters will warrant the increased fixed charges and operating costs.

The greatest interest lies in the limit of temperature that Drs. Mellanby and Kerr recommend, namely 900 degrees F. They arrive at this figure by departing from orthodox considerations. In the first place the ultimate tensile strength of metal as an index of its ability to withstand high temperatures is accepted only as a useful accessory fact, but not as a basis for making final decisions concerning the usefulness of that metal under the stated conditions of temperature. At first this seems to be contrary to accepted theory. Brief consideration will indicate that engineers have never used this ultimate strength as a design criterion without reservations. They have found by years of experience and by repeated failures that materials can never be loaded anywhere near either the yield point or the ultimate strength, and have adopted a large factor of safety to cover this deficiency. The working stresses are only a small fraction of the ultimate strength, and these limits, learned by hard experience, are actually safe loads below the ultimate fatigue limits of the metals under repeated strain. In other words, fatigue tests are of more value than pure tensile tests for judging the usefulness of metals.

A second factor is the property of metals at certain temperatures and loads to continue to stretch until failure occurs. British experimenters have investigated this property quite extensively. Mellanby and Kerr have studied these so-called "creep" experiments and have determined what appears to be the limit of loading at which creep stops at each temperature. They have considered this creep limit together with fatigue limits in fixing safe upper limits for steam temperatures. It is reasonable to assume that these factors are more reliable than tensile stress alone, and in consequence the limit of 900 degrees F. with materials now available, while somewhat surprising, is not at all improbable.

Expected plant performance with these pressure and temperature limits, twenty-nine inches vacuum, ninety per cent boiler and economizer efficiency, and with an allowance of five per cent for station auxiliaries, figures out to be about 9,875 B.t.u. per kilowatt-hour, corresponding to an over-all thermal efficiency of 34.5 per cent. This is about 0.73 pounds of coal per kilowatt-hour for coal of 13,500 B.t.u. per pound, a remarkable performance. The paper is valuable and will repay study, for it presents many interesting new viewpoints.

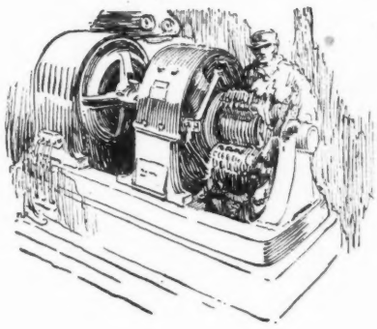
More To Be Gained by Co-operation Than Conflict

ALTHOUGH this country has gone farther than any other nation in the world to increase the productivity of human effort, this development has been accompanied by tremendous wastes of all kinds. One of these has been that resulting from the so-called struggle between capital and labor, and, strange as it may seem, not infrequently the struggle between different labor groups and in some cases between contending bodies in the same organization. Losses from these sources have run into billions of dollars. Anything that may be done to save a part of this will be well worth the effort. The report of the Federated Engineering Council made under the direction of Secretary Herbert Hoover revealed that waste in industry represented thirty per cent of the national effort, a sum that almost transcends human imagination.

When great national leaders in industry and labor sit down around the same table and discuss possible ways and means of eliminating this waste in industry, as was done in New York City recently under the auspices of the National Civic Federation, it is an event of more than passing interest and casts a ray of hope that America is finding a solution of the greatest of her economic problems. When the president of the American Federation of Labor goes on record as being in favor of greater efficiency in industry as a means of lowering prices, he is advocating something that, if put into effect, has great possibilities of eliminating some of the waste in industry. When the head of one of the largest industrial organizations in the country suggests that lower costs to the public may mean even greater earnings to workmen, he has made a suggestion that means more for everybody with the same amount of effort and is worthy of serious consideration.

As Secretary Hoover pointed out, it would be rash to assert that we have at last entered upon an industrial millennium, since there are still at times conflicts of interest between employer and employee. However, there are wide areas of active interest in which these two should coincide.

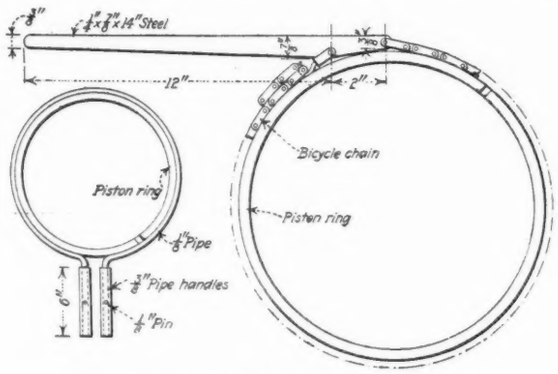
Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for March will be announced next month.

Piston-Ring Compressors

The illustration show two types of piston-ring compressors in use in our plant. The one shown at the left of the illustration is made from ⅜-in. pipe with pieces of ⅝-in. pipe over the ends for handles. As this type



Two types of piston-ring compressors

will fit only one size of ring, we have made one for each engine, and they are kept on the tool boards ready for use when needed. The other type, employing a bicycle chain and lever, will handle practically any size of ring and is readily adjustable.

Fessenden, N. D. D. W. LEWIS.

Emergency Armature Repair

A 50-hp. 220-volt direct-current motor that was in operation practically 24 hours a day developed trouble and blew the fuses. Upon testing, it was found that one commutator bar was grounded at the back of the commutator. The spare armature was at this time being rewound, therefore it was a case of making some kind of a repair to get the machine back into service as quickly as possible.

If it had been a coil that was grounded, the job would have been easily done by cutting out the defective coil, but a ground on a commutator bar made the repair more difficult. I therefore decided to try what was a new stunt to me. The two coil leads connected to the grounded bar were removed and bent back out of the way. This resulted in cutting out two coils. I then took a piece of fiber and tapped the grounded commutator bar down lower than the others and then covered this bar with water glass. This solution dried quickly and made an insulating film over the bar. The open circuits caused by the removal of the two leads were then closed.

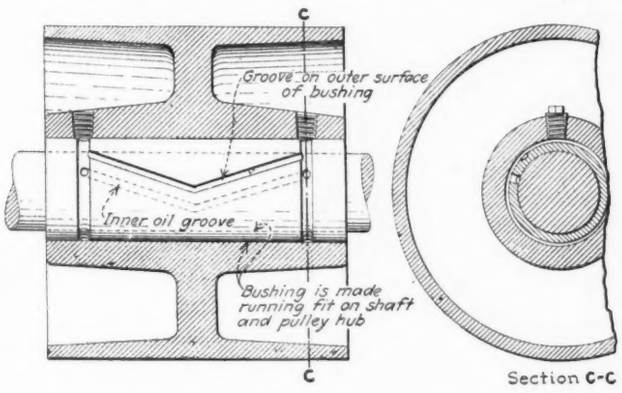
When the motor was started, it was found to operate fairly satisfactorily. There was, of course, some flashing every time the insulated bar went under a brush, but not enough to do any damage. The motor was run in this condition for three days and nights without causing any further trouble. FRANK HUSKINSON.

Phoenix, Ariz.

Use of Floating Bushing in Loose Pulley Improves Operation

To many engineers the loose pulley is a constant source of annoyance, due in most cases to the difficulty of keeping it properly lubricated. Our machine-shop staff feel they have made a long stride in solving this problem.

Instead of making the bushing a force fit in the pulley hub, it is made a running fit in the hub as well as on the shaft. A groove is turned around the outside of the bushing at each end, so located as to come fair with the oil hole in the pulley hub. Two holes



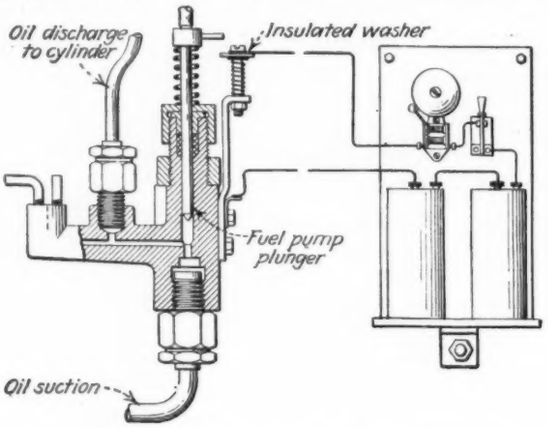
Bushing is a running fit in hub and on shaft

are drilled through the bushing in the circular oil grooves, and an oilway is cut at an angle with the center line on both the inner and outer surfaces of the bushing, as shown in the illustration. This construction requires a collar at both ends of the hub except where the tight pulley hub comes flush with the rim. J. O. BENEFIEL.

Anderson, Ind.

Electric Bell as Watchman on the Oil Engine

Not infrequently, engineers in small plants are required to do other work in addition to their regular duties in the engine room. In cases where these duties take them some distance from the engines, some sort



Bell gives warning of abnormal change in speed of the engine

of signal that will give advance warning of trouble will prove a convenience, and often save repair bills.

In our plant, where oil engines are used, we have rigged up the alarm shown in the illustration. The adjusting screw is set so that the insulated washer will just clear a pin in the pump plunger at normal load and speeds. Should the water pump or lubricating pump fail to function properly, or not sufficient water be injected, as in the case of the water-injection types of engines, the engine will knock and slow down, causing it to pump in heavy charges of fuel and possibly stop before the engineer can get to it. With the arrangement shown herewith, the bell will ring with any appreciable change in the speed or movement of the governor and will warn the engineer before any damage is done.

J. C. WALDNER.

Roley, Alberta, Canada.

Some Causes of Troubles in the Power Plant

Occasionally, engineers encounter troubles in the operation of certain pieces of equipment for which there is no apparent cause, and often considerable time elapses before the real cause of the trouble is found.

A typical example was brought to my attention some time ago by an engineer who told me of the packing troubles he had had on a large Corliss engine.

The piston rod on this engine required repacking every two or three weeks. After several different makes and grades of soft packing had been tried with unsatisfactory results, the rod was carefully examined, but it appeared to be in good condition. Metallic packing was then tried with about the same results. It was finally decided to withdraw the piston and rod and examine them thoroughly. When this was done, it was found that the rod was bent a few inches from the piston, the bend being sufficient to disturb the packing at each revolution of the engine. When the rod was straightened, there was no further trouble with the packing.

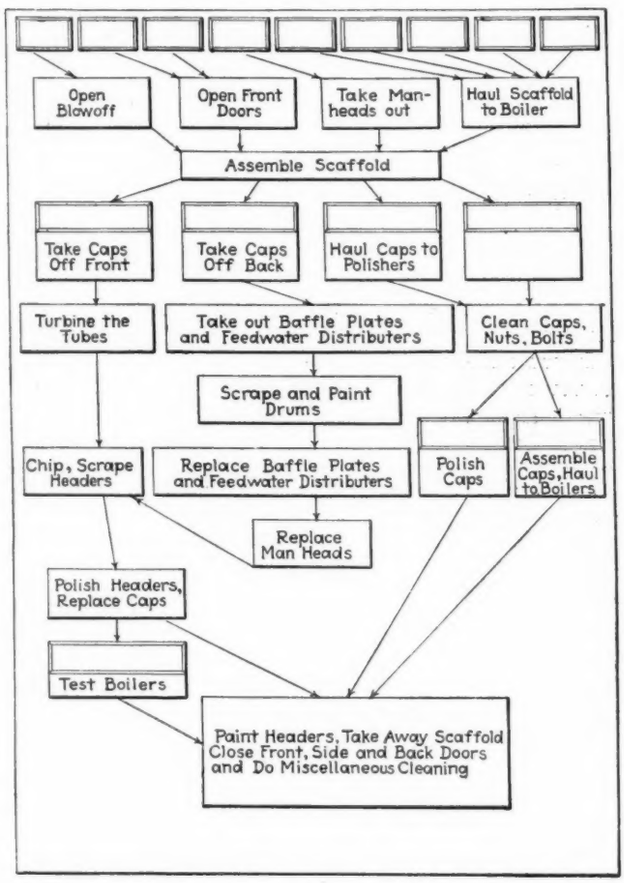
It was later found in this plant that the water columns on the boilers were placed much higher than is the usual practice. When the water was just showing in the bottom of the gage glass, there was still nine inches of water over the tubes. As the boilers were of the horizontal return-tubular type, this reduced the steam space considerably. The engineer attributed the cause of the bent piston rod to the faulty location of the gage glass, owing to the fact that with the water at the usual operating level, slugs of water would carry over into the engine with the steam, whenever there was an appreciable change in load.

The owners of the plant gave as their reason for locating the water columns in this position, that should any of the boiler-feeding apparatus fail while the boilers were in operation, there would be sufficient time to make repairs or get another pump in service before the water reached a dangerous level in the boiler.

Milwaukee, Wis. H. A. JAHNKE.

Speeding up the Boiler Cleaning by Posting Routine To Be Followed

The illustration shows a scheme used in our plant to facilitate and hurry the work of boiler cleaning. The names of the men employed in this work are written


Open Blowoff
Open Front Doors
Take Man-heads out
Haul Scaffold to Boiler
Assemble Scaffold
Take Caps Off Front
Take Caps Off Back
Haul Caps to Polishers
Turbine the Tubes
Take out Baffle Plates and Feedwater Distributers
Clean Caps, Nuts, Bolts
Scrape and Paint Drums
Chip, Scrape Headers
Replace Baffle Plates and Feedwater Distributers
Polish Caps
Assemble Caps, Haul to Boilers
Replace Man Heads
Polish Headers, Replace Caps
Test Boilers
Paint Headers, Take Away Scaffold Close Front, Side and Back Doors and Do Miscellaneous Cleaning

Blackboard shows the names of the men, jobs to be done and routine to be followed

on cards at the head of the board. The arrows show the jobs to be attended to, the order in which they come and the men who are to do them. The same plan is followed out for other routine work.

Redondo Beach, Calif. W. E. THOMPSON.

Measuring Coal on Traveling Grate Stokers

The employment of scales for weighing the coal to each boiler is to be recommended wherever possible, but if your plant is equipped with traveling-grate stokers you have a natural means of computing the coal consumption. Every make of traveling-grate stoker has a feed gate that can be raised or lowered to regulate the thickness of fuel bed. Knowing the height of this gate above the grate, the width of the stoker and the speed of the grate, it is a simple matter to calculate the volume of coal used per hour.

The density or weight per unit volume of different coals varies, but, generally speaking, a cubic foot of bituminous coal weighs about 50 lb. With this weight as a standard, the accompanying table was computed to show the coal consumption in pounds per hour with a grate speed of one inch per minute. For any other speed simply multiply the figures in the table by the indicated speed per minute.

As an example, let us take a stoker 9 ft. wide with the feed gate set at 7 in. and traveling at a rate of 4 in. per min. Referring to the table, we find that 1,306 lb. per hour will be used if the stoker travels at 1 in. per minute. Multiplying by 4 we get 5,224 lb. per hour.

COAL CONSUMPTION PER HOUR ON TRAVELING-GRATE STOKERS WITH GRATE SPEED OF ONE INCH PER MINUTE

Gate Height in Inches	Stoker Widths in Feet *Pounds per Hour																
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	125	145	166	187	208	228	249	270	291	311	332	353	373	393	414	435	456
2	249	291	332	374	415	457	498	540	581	623	664	706	745	787	828	870	911
3	373	436	497	560	622	686	748	809	872	935	995	1,060	1,120	1,180	1,240	1,303	1,365
4	498	582	664	746	830	915	997	1,079	1,160	1,245	1,330	1,410	1,490	1,570	1,655	1,740	1,820
5	625	726	830	934	1,038	1,140	1,242	1,348	1,450	1,555	1,660	1,765	1,865	1,960	2,065	2,170	2,280
6	748	872	996	1,120	1,242	1,370	1,490	1,618	1,745	1,865	1,990	2,120	2,240	2,360	2,480	2,610	2,730
7	873	1,016	1,162	1,306	1,450	1,600	1,740	1,888	2,030	2,180	2,320	2,470	2,610	2,750	2,890	3,040	3,185
8	998	1,160	1,330	1,492	1,660	1,825	1,990	2,158	2,320	2,445	2,660	2,820	2,980	3,140	3,310	3,478	3,640
9	1,125	1,308	1,495	1,680	1,870	2,055	2,240	2,425	2,610	2,800	2,980	3,170	3,350	3,530	3,720	3,910	4,100
10	1,245	1,453	1,660	1,868	2,075	2,283	2,490	2,698	2,905	3,113	3,320	3,528	3,725	3,933	4,140	4,348	4,555
11	1,370	1,600	1,825	2,058	2,281	2,510	2,740	2,960	3,200	3,420	3,650	3,880	4,100	4,320	4,550	4,770	5,010
12	1,495	1,745	1,990	2,240	2,490	2,740	2,930	3,230	3,490	3,735	3,980	4,240	4,460	4,720	4,960	5,210	5,460

*Pounds per hour are given on basis of 50 lb. per cu.ft.

If you think the coal you are using does not weigh 50 lb. per cu.ft., it is a simple matter to check the weight with a small scale. As a container for the sample, any box or bucket of known capacity will suffice. Supposing you have an ordinary 14-qt. bucket and after filling this level full you find the net weight to be 22.5 lb. This would mean that your coal weighs 48 lb. per cu.ft. It is advisable to take the weight of three or four bucketfuls and then use the average as your standard. The following is the capacity of different sizes of buckets and baskets: 8-qt., 0.268 cu.ft.; 10, 0.335; 12, 0.402; 14, 0.469; 1 peck, 0.32, and 1 bushel, 1.27 cu.ft.

In most cases bituminous coal will run very close to 50 lb. per cu.ft., while anthracite will average between 54 and 60 lb. per cu.ft. Commercial coke breeze, if dry, weighs about 35 lb. per cu.ft. This fuel, however, is of such porous character that when wet the weight of a unit volume will vary considerably. It will hold from 10 to 15 per cent moisture and will then weigh around 40 to 45 lb. per cu.ft. This means that if you are burning anthracite, the results just given for the different sizes of buckets should be multiplied by a factor of approximately 1.1, or if you use coke breeze of 35 lb. per cu.ft., multiply by 0.7.

After the fuel-bed thickness has been determined for the kind of coal you are using, the feed-gate height can usually remain the same day after day unless there is some radical change in the quality of the fuel or in the average load of the boiler. With the fuel-bed thickness constant, there is only one variable to contend with —the grate speed. There are different ways of determining this, the best being some sort of revolution counter. With this method the figures in the dial can be read every hour, or once a shift or at any given interval.

If, however, you do not have a revolution counter and want to get a record of the grate travel, you can do so by making a mark on one of the links or clips near the side frame and then by means of a rule and a watch, catch the speed between two points. There is also another way. If you know the ratio of the gear reduction you can, by getting the number of revolutions of the main worm per minute obtain the grate speed very easily.

Ordinarily, in attempting to measure the grate travel with a rule difficulty is encountered because the flat or horizontal surface of the grate is inaccessible behind the coal hopper. The detachable apron forming the front of the coal hopper extends so far forward that the links do not lie flat until they get under the apron. For this reason counting the revolutions of the main worm is much easier. If you do not know the relation between the revolutions of the main worm and the grate travel, it is a simple matter to get this figure some time when there is no fire on the grate. Remove the front apron and make a chalk mark on one of the links near the side just as it is about to move into a horizontal position. Then with a watch in one hand and a piece of chalk in the other, make a mark on the side frame just even with the mark on the link just as you catch the time with the second hand of your watch. At the end of one minute again make a mark on the side frame even with the mark on the link. The number of inches between the marks on the side frame will be the amount of grate travel per minute. Next, with the stoker running at the same speed, check the number of revolutions per minute of the main wormshaft. The number of inches of grate travel per minute divided by the number of revolutions of the main worm will then give the factor that may always be used for that size and type of stoker for determining grate speed.

Sometimes there are no means of measuring either the coal or water. After using the foregoing method to obtain the coal weight, the output of the boiler can be calculated if you have any idea of the efficiency of stoker and boiler and the heat value of the coal, or the output in pounds of steam per hour can be computed by assuming an evaporation of 7.5 lb. of water per pound of coal and multiplying this by the pounds of coal burned per hour.

J. R. DARNELL.

Worcester, Mass.

Comments from Readers

The Value of a Relief Valve

With reference to my article in the Feb. 17 issue, entitled "The Value of a Relief Valve," the cause of the deformation of the tank was not brought out. In order to forestall any misapprehension as to the cause of the trouble, I should like to submit the following explanation:

A large quantity of water was used between four and five p.m. and again at eleven p.m. This lowered the temperature of the water in the tank to around 70 or 80 deg. As all the valves were tight and the relief valve had been removed temporarily, the expansion of the water due to heating caused the tank to yield at the weakest point.

R. McLAREN.

Toronto, Ont., Canada.

Diagrams from Low-Pressure Cylinder with Condensing and Non-Condensing Operation

I have given much thought to the indicator diagrams in the article by Mr. Hampshire in the Feb. 17 issue. It would appear that the two diagrams were not taken from the one setting of the indicator; if not, no doubt there was some change in the pencil movement and the cord adjustment.

I have had considerable experience in indicating different types of steam engines, air compressors and pumps, running at high and low speeds. In considering a diagram it is necessary to keep in mind that a number of things can happen in the handling of an indicator that will make the diagram worthless. Some of these points have been explained a number of times in *Power*, so I will only mention a few that I think might have caused the unusual diagram.

In taking the two diagrams shown by Mr. Hampshire, it was necessary to use a light indicator spring,

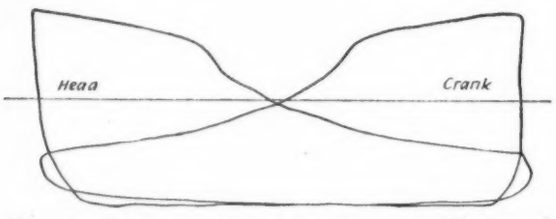


Fig. 1—Diagram from low-pressure cylinder of compound engine running condensing

which would make the indicator rather sensitive. The indicator cylinder and piston may have needed oiling or it may have been oiled with too heavy an oil. Dirt may have been forced into the indicator owing to working at a higher pressure, or the pencil may not have been properly adjusted.

The two diagrams shown herewith were taken from the low-pressure cylinder of a 12x22x36-in. cross-compound Corliss engine, running at 75 r.p.m. From the two diagrams it can be seen just what might be expected when the indicator is working properly.

Norway, Mich. THOMAS PASCOE.

From a study of the diagrams shown by Mr. Hampshire, I can well believe that engineers have told him they had never seen a diagram before similar to the one shown in Fig. 2 of his article. In my opinion the diagram shows certain features that could not exist

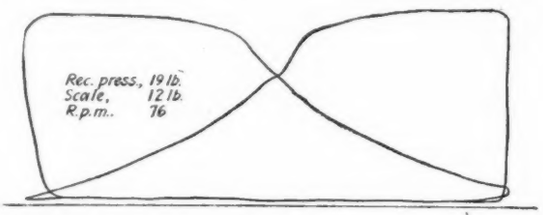


Fig. 2—Diagram from same cylinder as Fig. 1 with engine running non-condensing

with any valve setting, with an engine in the same condition as when the diagram Fig. 1 was taken; namely, negative loops in the middle of an expansion line and positive loops at the end of the stroke and below the atmospheric line.

Without more details as to the condition of the engine when Fig. 2 was taken, I would suggest that Mr. Hampshire overhaul his indicator and reducing motion.

Los Angeles, Calif. J. W. CARR.

Water Level and Its Relation to Feed-Water Input

The article by Charles L. Hubbard on "Feed-Water Regulation," in *Power*, March 24, emphasizes that the water level in a steam boiler has always been an item of considerable interest.

In the early days a great deal more dependence was placed on the try-cocks than on the visible level in the gage glass. In fact, the glass was frequently omitted. The water column then came into use, and it became necessary to place the connections in such places that a true indication of the boiler-water level would be had.

Since a high level was likely to cause water to pass into the steam line and a low level to cause burning of the boiler, it was natural to insist that the water level be carried at some particular place between the two danger points, as far away from both of them as possible.

With the advent of feed-water regulators it was natural for the designers of such machines to strive to produce a constant water level to satisfy the common demand. It was frequently stated that feeding exactly in proportion to the load increased the boiler efficiency and that a variable water level produced strains in the boiler shell on account of the variable

temperature in the part alternately exposed to steam and water. Apparently, it was not realized that the water at this point is at the same temperature as the steam.

Owing to the fact that the volume of the fluid in a boiler changes with its load, any attempt to hold a constant water level leads to the introduction of large quantities of water at one time and cutting off the feed entirely at other times. Therefore, feed-water regulators operating to maintain a constant level were intermittent in action. A drop in load from full to half rating reduces the volume of the fluid in the boiler and the level drops an inch or more. It requires the immediate introduction of some 600 lb. of water to bring this level back on a two-drum longitudinal 5,000-sq.ft. boiler. It is evident that the water level should be allowed to move through a given range to prevent any rapid change in flow. A little thought will show that with a varying load, which means varying evaporation, the nearer the water is held to a fixed point, the more intermittent the water input must be.

The chart in Fig. 1 shows the input of feed water to a boiler equipped with an intermittent type of feed-water regulator. Fig. 2 shows how the feed-flow curve was smoothed out after the boiler was equipped with a continuous-flow type of feed-water regulator. With this latter regulator no attempt was made to keep the water level at a fixed point. It varied within certain fixed limits, but always under definite control and in accordance with furnace and load conditions.

The saying that water seeks its own level is only partly true in a boiler. Variation in specific gravity produces circulation. This and the pressure on the surface affect the water level. The level shown in the gage glass is often not the level in the boiler, nor in that part near the gage glass.

Tests of longitudinal-drum water-tube boilers showed a hump in the water level over the front water leg, only part of which was indicated in the gage glass.

The point of connection of the water column to the boiler has a relation to the level indicated. For instance, if the water connection is made to a point near the bottom of the boiler, the cold water in this leg will balance a higher column of hot water in the boiler, which may also contain steam in suspension, further reducing its specific gravity. The level in the glass will be several inches to several feet lower than the level in the boiler, depending on the load and the distance below the water level that the connection is made. The water level in the glass may be higher than that in the boiler if the water-column steam connection is made near the main steam outlet, or if the water connection is made in front of a tube in such a manner as to be affected by the velocity of the water discharged from the tube.

In the same boiler there are considerable differences in water level. In longitudinal-drum boilers there is frequently as much as 5 in. differences in level in the drums due to a slight pressure difference. Cross-drum boilers may have higher water on one end of the drum than on the other, or higher levels behind the baffle than in front of it. Lancashire boilers have higher levels over the fireboxes than on the sides of the drum. Vertical boilers with a central gas baffle have higher levels in front of the baffle than behind it. These differences are due to circulation.

Since the circulation of a boiler is considerably affected by the admission of the feed water, it is evident that the feed should be continuous as long as there is load on the boiler and should be distributed as evenly as possible. If a manifold is used on multi-drum boilers, it should be so designed that each drum is fed from a common point through the same size and length of pipe containing the same fittings. The usual method of arranging the manifold causes most of the water to flow into the nearest drum. This drum will have the lowest water level, and incidentally, the tubes under this drum will contain most of the scale and must be most often renewed. Cross-drum boilers should be fed from both sides, as it is impossible to distribute

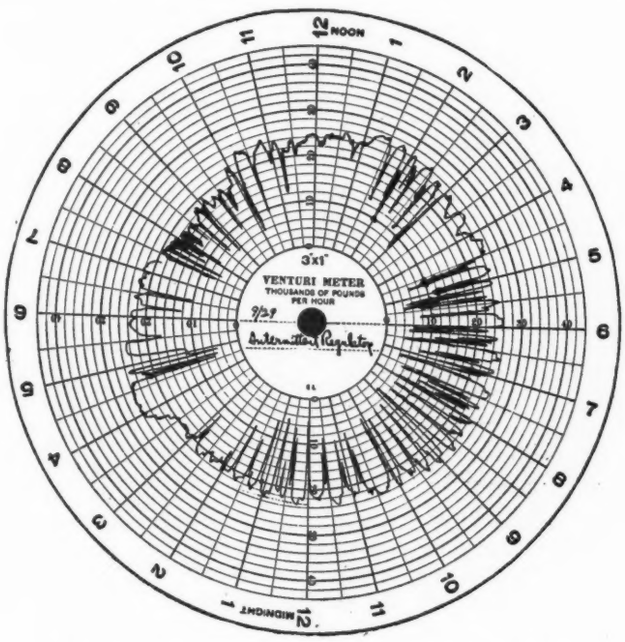


Fig. 1—Feeding with intermittent regulator

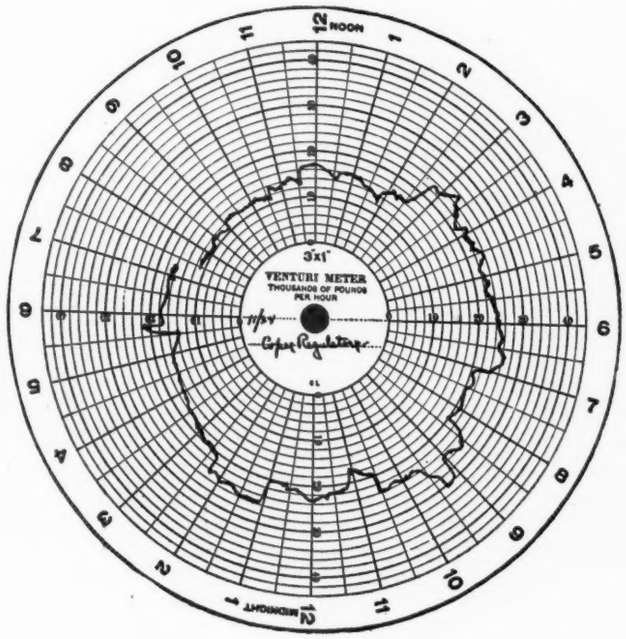


Fig. 2—Continuous-flow regulator was used

the feed equally from one side. The level will be lowest on the side getting the most feed.

Feed-water regulators designed to give continuous feed at all times while the boiler is under load, and which increase the feed during light loads and decrease the feed during heavy loads, assist considerably in the proper distribution of water, but the same care should be used in connecting the regulator to the boiler as in locating the water column. G. J. COPES.

Erie, Pa.

"Get Started"

I have just read the Foreword in the Feb. 10 issue entitled "Get Started," and wish to compliment you on the thought brought out.

For many years I have expressed the opinion that an inefficiently operated boiler plant could have the majority of the possible improvements made without the aid of any meters or even a thermometer or draft gage. Take for instance the horizontal water-tube boiler and five minutes' observation will show the major points of both combustion and heat-absorption efficiency regardless of whether oil or coal is being burned.

First, an inspection in the first pass will enable one to see whether the firing is being done with proper excess air and whether it is uniform over the furnace or badly stratified. If there is no flame at all at the bottom row of tubes, there is too much excess air. If a clean flame tips up about halfway through the first bank of tubes, it is about right. If the flame, however, extends up through the first pass, there is too much unburned gas and probably smoke.

At the same time the first pass is being observed for combustion conditions and stratification of flame, one should observe the cleanliness of the tubes on the fire side.

The next point of inspection is in the second pass. If the fire is being operated with deficiency of air, a blue or pinkish flame of CO will often extend well down or entirely through the second pass. This, of course, should be remedied immediately. Another source of considerable loss is often detected by observing conditions in the second pass. If the front baffle is defective, the flame will be found short-circuiting through holes or cracks. Leaks in the front baffle often bypass a considerable portion of the two passes (the pass up and pass down) of the boiler and greatly reduce the efficiency, owing to the resulting high exit gas temperature. The second pass should be perfectly dark without flame coming over either through normal channels or through the front baffle.

These observations are somewhat akin to the physician who, when he calls upon a patient, takes his pulse and temperature. In spite of his elaborate training and experience he always falls back on the simple indications and no doubt diagnoses a large number of his cases from elementary observations.

In the boiler plant if a man is interested enough in his work to look into the points just mentioned as well as observe the ash pile, which he can analyze by the eye with considerable accuracy, and observe the cleanliness of the tubes on the inside when the boiler is open for inspection, he will save the major part of the improved efficiencies possible. After getting interested to this extent, he will find it best to go a step farther and secure suitable metering equipment, preferably of the recording type, to make sure that efficiencies have been maintained throughout the twenty-four hours of every day. However, if each individual fireman would conscientiously make the foregoing observations, the efficiency would be obtained without the necessity of so many meters and instruments, except to obtain the last per cent of efficiency and render the assurance that it had been obtained.

It has been my experience that a man who is sufficiently interested in his work to make these observations takes better care and gets more results from meters after they are installed; in other words, the whole thing is to "Get Started" and show interest in one's work.

The observations spoken of in connection with the horizontal water-tube boiler cannot be made so readily in other types or even the modern types of boilers piped up for soot blowers and having none of the old style openings for the hand lance. However, inspection doors and even periscopes are a good investment provided the man will use them. E. G. BAILEY, President,

Cleveland, Ohio. Bailey Meter Co.

Utilizing Waste Firebrick

In the Jan. 20 issue J. A. Faulkner refers to an article by Joseph Harrington on "Ground Firebrick for Furnace Repair," in the June 17, 1924, issue, and mentions certain economies effected by grinding up old firebricks and mixing with high-temperature cement, thereby producing a furnace lining much cheaper than relining with brick or other refractory material.

This process, it would seem to the writer, can be of benefit only to certain plants. If, for instance, a plant has a number of men employed who have little or nothing to do excepting at times when there is furnace trouble, it may appear economical to turn those men on to brick grinding and preparing some mixture the engineer considers efficient for furnace lining. And on working out the cost of labor only, as the bricks will be considered of no value, and adding on the price of the fireclay and cement, the apparent cost is less than if the engineer had ordered direct from some refractory-materials manufacturer.

But, is this the right way to look at economy? If one takes everything into consideration, is there really any economy? First of all, if the plant has a number of men on the payroll that have sufficient spare time to prepare refractory material, does this not prove there is more labor about the plant than necessary? The cost of power, if the grinding is done by machinery, the interest on the invested capital for the machinery, together with the repair and upkeep cost, should be taken into consideration, and perhaps if the actual cost were worked out, the process would not appear so economical.

Refractory material, like everything else, is a specialty. A manufacturer turning out a furnace lining that has been properly tested and is known to give good results, is in a far better position to supply material at an economical cost than an engineer who has time on his hands to make experiments that may or may not be successful. The engineer is simply repeating work that has already been done in a scientific manner by some manufacturer who has had everything at hand to turn out a refractory lining that is sure to give results, the former is probably wasting good time experimenting with some old brickbats instead of doing something more beneficial to his plant.

Buenos Aires, S. A. JAMES JOHNSTON.

Questions and Answers

Conducted by

Franklin Van Winkle

Temporary Covering for Back Connection

In case the back arch of a return-tubular boiler fell in while carrying a heavy load, how could the plant be kept going? *R. L. G.*

It would be necessary to cut the boiler out of use during replacement of a covering to take the place of the fallen arch; and the load would have to be kept within the capacity of other boilers of the plant. A temporary repair could be quickly made by bridging over the back connection with loose brick supported on a bridging of heavy iron like old grate bars and covering the brick with a sufficient depth of loam or clay to be fairly draft tight.

Head Pressure Pumped Against

What determines the head pressure against which a steam pump will operate? *J. H. C.*

In addition to overcoming the head pressure, the total pressure exerted by the steam piston must be capable of overcoming the friction of the water in the pump passages, suction and discharge pipes, depending on the velocity of the water; also the pressure required to open the foot valve when used and pressure required for overcoming the friction of the pump parts on each other. Hence it follows that the head pressure per square inch that the pump will operate against will be the net area of the steam piston in square inches, multiplied by the available steam-cylinder pressure per square inch, less the pressure per square inch required to overcome the other resistances, divided by the gross area of the water piston. To cover all resistances, pumps used to deliver feed water against the same boiler pressure as the pressure of steam supplied to them usually have steam pistons about twice the area of the water pistons.

Why Pull of Potential Switch Coil Is Weak

What causes a magnet switch coil on an elevator controller board to lose its energy or pulling power? I have a potential switch coil that seems to be losing its energy and will barely close the switch. Would it help to change the direction of the coil current? *J. H. H.*

It would be of no benefit to change the direction of the current through the magnet coil on the potential switch. It may be that part of the turns are short-circuited in the coil. However, the trouble probably will be found in some of the contacts connected in the potential-coil circuit. On a drum-type elevator there will generally be the slack-cable switch, the limit switches in the elevator hatchway, and the emergency switch in the car connected in this circuit. On traction-type machines the potential coil circuit will usually include a single-pole switch on the control board; a contact or a magnet switch on the board, the coil of which is in series with the field circuit; a contact on the governor switch, limit switches at both the top and bottom of the hatchway; an emergency switch in the car; and a safety switch on the safety plank under the car. It is probable that some of these contacts have become dirty and increased the resistance of the circuit to the point where the coil is weak. It may also be possible that there is one or more loose connections in the circuit.

Importance of Oil Separator on Exhaust-Steam Heating Plant

When exhaust steam is used for heating, is it necessary to use an oil separator? *G. R. D.*

The exhaust from steam turbines rarely contains enough oil to be objectionable; but reciprocating engines and the steam cylinders of direct-driven steam pumps are generally supplied with valve and cylinder lubricating oils which should be removed by an oil separator before the exhaust is supplied to a steam-heating apparatus. When discharged in the exhaust, the oil is likely to cause leakage at joints and packings, clog valves and steam passages and cause deposits of heavy oil in traps and pockets in the piping and radiators, which are difficult to remove.

Power Lost by Shafting Friction

How can the horsepower lost by friction of shafting be determined? *T. S. M.*

The power absorbed by shafting varies with the length, speed, alignment, character of bearings, weight of shafting and pulleys and tension of belts or pressure from gearing. Most of these conditions are variable, and close determination of power lost for a given set of conditions requires application of a dynamometer.

When steel shafting is in fair alignment and runs in babbitted bearings, the power lost by friction for each bearing is closely given by the formula,

$$N = C \times d \times W \times r.p.m.$$

where,

N = Number of horsepower absorbed in journal friction;

C = 0.00000056 for ordinary oiling;

C = 0.00000034 for continuous oiling;

d = Diameter of journal, in inches;

W = The resultant pressure on the bearing from weight of shafting and pulleys, pressure from gearing and tension of belts, in pounds;

$r.p.m.$ = Number of revolutions of shaft per minute.

Under average conditions the sum of tensions of tight and slack sides of leather belts may be taken as 100 lb. per inch width for single belting and 180 lb. per inch width for double belting.

Cutoff Inadmissible for Direct Steam Pump

Why is not lap given to the steam valves of an ordinary duplex steam pump, to obtain cutoff with the advantage of working the steam expansively? *J. H.*

The valves cannot have lap for cutting off the steam supply at a fraction of the stroke, as the pump must be able to start from any point. In addition to this requirement, the steam piston is called upon to exert the same pressure the full length of the stroke. With cutoff at a fraction of the stroke, the pressure of the steam would be reduced below the required average pressure before completion of a stroke, and in the ordinary duplex steam pump there is no flywheel effect as in an ordinary engine for distributing the energy of the steam over the whole stroke.

Bridge Walls and Combustion Chambers for H.R.T. Boilers

What is the best form for the furnace bridge wall of a horizontal return-tubular boiler, and what advantage, if any, is gained by having the floor of the combustion chamber in the form of an inverted arch near the bottom of the boiler? *R. A. C.*

The main purposes of a bridge wall are to force the air up through the fuel bed and to prevent the coal from falling off the grates. The shape of the wall, whether flat on top or curved to correspond with the form of the boiler, or whether the sides are vertical or sloping, appears from tests to make no difference provided the area over the wall is sufficient not to check the draft, and for that purpose it should be somewhat larger than the gross area of the fire tubes. Hence the most practical form is a vertical flat top wall, coped with bull-nose firebrick at no greater height than suitable for working the fire. By having a low bridge wall, less surface is presented to reflect heat of the furnace to the front wall and firedoors, and the boiler shell will receive less impingement of the hottest gases.

No advantage is gained from having the bottom of the combustion chamber higher than the level of the ashpit floor. It is well to pave the floor and have it slope a little to facilitate removal of soot and cinders, but the floor should be raised no more than necessary for that purpose, as headroom is valuable for making inspections and repairs.

Calibration of Pressures Shown by Indicator Diagrams

How may indicator springs be tested for determining the truthfulness of pressures shown on diagrams? *L. B.*

Calibrations should be made with the spring in the same instrument as used for making the diagrams, and as far as possible all adjustments and other conditions should be identical. For practical purposes it usually will be sufficient to compare the rise of the pencil with indications of an accurate steam gage. For this purpose the indicator and the standard pressure gage should be connected near together on the side of a ½-in. or larger steam pipe that is provided with a valve for draining and also with a discharge valve on one side of the instrument and connected on the other side with the same or a larger size of pipe and stop valve to a steam line or other boiler connection from which dry steam can be drawn of pressure higher than the highest desired test pressure.

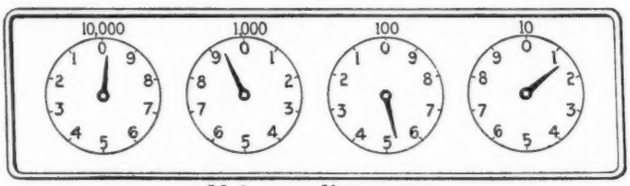
By manipulating the supply stop valve and the discharge valve, while leaving the drainage valve open a very little, different test pressures can be obtained for comparing the indicator with the standard gage. The instant the desired pressure is indicated by the standard, strike a line on a blank card previously placed on the indicator paper drum, by drawing out the drum cord with one hand and a light pressure on the pencil motion with the other.

Tests should thus be obtained on a number of cards for equal intervals of 5 or 10 lb. pressure. When a sufficient number of different test pressures have been located on a card, and before removing the card from the paper drum, strike a line to represent atmospheric pressure. A sufficient number of test cards should be made to obtain at least three that agree. Others should be disregarded. By making tests at equal intervals of pressures, variations from uniformity of rise of the pencil are readily detected and more easily compared with an accurately divided scale.

Reading of Meter Dials

What is correct reading of registration of meter dials when standing as shown in the sketch? *D. M.*

The figure outside of a dial indicates the number of units registered for one complete revolution of the pointer of the same dial, and the figures within the



Meter reading, 9,951

dial give fractional parts of a complete revolution. Since a complete revolution of the pointer of the dial marked 10 gives one-tenth of a revolution of the dial marked 100, it follows that for a complete revolution of the pointer of the 100 dial there must be 10 complete revolutions of the pointer of the 10 dial, $\frac{1}{10}$ of the rotation of the pointer of the 1,000 dial, and $\frac{1}{10}$ of $\frac{1}{10}$ of the complete revolution of the pointer of the 10,000 dial. The whole registration shows completion of $\frac{9}{10}$ of 10,000 + $\frac{5}{10}$ of 1,000 + $\frac{1}{10}$ of 100 + $\frac{1}{10}$ of 10; or a net reading of 9,951.

Leakage After Removal of Boiler Scale

If a boiler, previously tight, leaks when put in use after removing scale, how can the leaks be stopped without shutting down for the purpose? *T. R. C.*

Small leaks below water line generally can be stopped by adding corn starch to the feed water. Five to ten pounds should be sufficient for a boiler of average size. At any time when the leaks are so bad that the water level cannot be maintained with an easy rate of feeding the boiler should be cut out of the steam lines and proper water level held while fires are drawn and the setting is allowed to cool prior to blowing off the boiler for needed repairs.

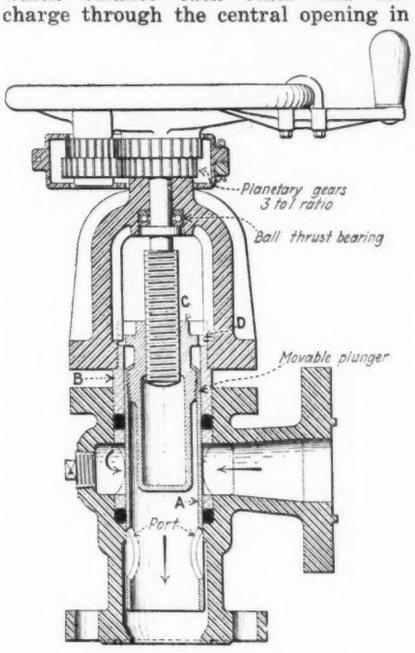
[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication and for the inquiries to receive attention.—EDITOR.]

New and Improved Equipment

Yarway Balanced Seatless Blowoff Valve

To meet the present requirements for higher pressures, the Yarnall-Waring Co., Philadelphia, Pa., has brought out the balanced seatless blowoff valve (Model B) shown in the illustration.

This valve, like the model A, which has been made for some years by this company, has a movable plunger, but instead of having one port in the side of the plunger there are two ports on opposite sides, which coincide with the ports in the follower ring when the valve is open. The body of the valve has an annular space connected with the inlet port so that when the valve is open there are two opposing jets which balance each other and discharge through the central opening in



Model B balanced valve in closed position

the plunger. This design also provides for even distribution of pressure around the plunger.

The plunger is made in two parts. The head *C* is screwed into a hard drawn bronze tube *A*, the head end of the tube being rolled over, as shown, to prevent leakage. The method used in model A, of compressing the packing rings by turning the handwheel down hard, has been retained. This is accomplished by the shoulder *D* on the plunger engaging the follower ring *B*.

Additional features of the new model are a ball-thrust bearing fitted in the yoke to absorb the thrust of the spindle in closing the valve and the employment of a planetary gear with a 3 to 1 ratio in the drive between the handwheel and the valve spindle.

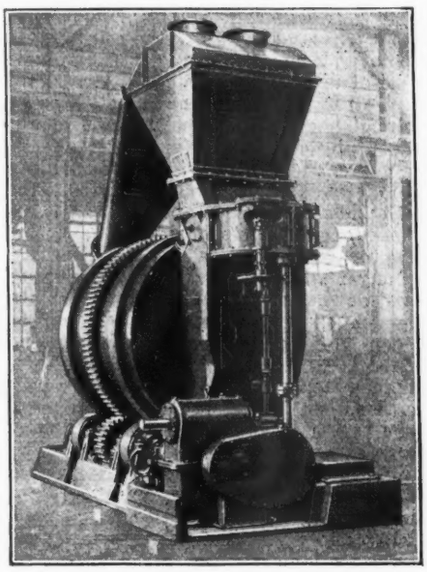


Fig. 1—General view of mill from feeder end

Bonnot Unit-Air Ball Mill

Simplicity and slow speed are features of the unit pulverizer recently developed by the Bonnot Co., Canton, Ohio. A general view of the machine is shown in Fig. 1 and a partial section in Fig. 2.

The machine consists essentially of a feeder, a revolving cylinder in which a charge of grinding balls reduces the coal to the necessary fineness, an interior classifier, an exterior separator and an exhaust fan. With the exception of the exhauster the entire unit, including the motor for driving, is mounted on one bedplate.

The raw coal is fed to the mill by a slow-speed disk feeder driven from a countershaft on the mill, variation of the coal supply being made by adjusting the position of the control handwheel *B* either by hand or automatically with a pressure regulator. From the feeder the coal passes directly to the grinding cylinder, where it is reduced to the required fineness by the impact of cascading balls as the cylinder rotates. The speed of the cylinder is slow, a 1½-ton mill operating around 30 r.p.m. The reduction in speed between the motor and cylinder is accomplished by a speed reducer of the worm and gear type mounted on ball bearings and totally inclosed.

The cylinder is lined with rolled steel bars or Linerite (a rubber wave-type lining), the choice of lining being optional. The balls that form the grinding media occupy about 30 per cent of the mill volume, and new balls can be added as required without stopping the mill.

A preliminary classification of the coal is accomplished inside the mill by means of a perforated steel pipe *C* (Fig. 2) concentrically located in the cylinder and connected to the outlet opening of the discharge end of the cylinder. As the coal is reduced to the required fineness, it is removed from the mill in a current of air induced by the exhauster. In passing through the separator *D* any oversize particles that have been carried over are separated and returned to the mill by gravity for further grinding. The fineness of the coal leaving the mill is controlled by adjustment of the air through the separator. Other features of the mill will be apparent from a study of Fig. 2.

The pulverizers are made in sizes ranging from 1½ to 8 tons per hour.

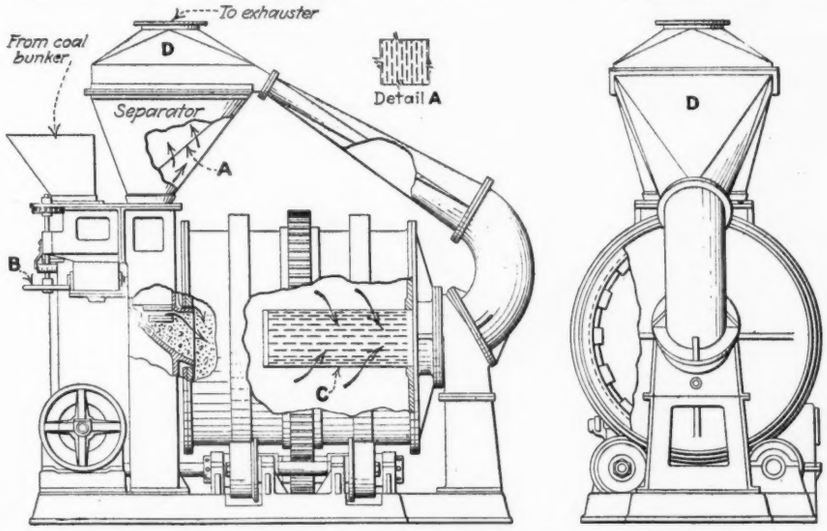


Fig. 2—Partial section of mill showing preliminary classifier

Electromagnetic Manometer

A type of electromagnetic manometer designed primarily, for boiler steam-flow measurement, but which lends itself readily for other purposes, such as the measurement of small differences in the level of liquids and of the flow of gases other than steam has recently been introduced in England.

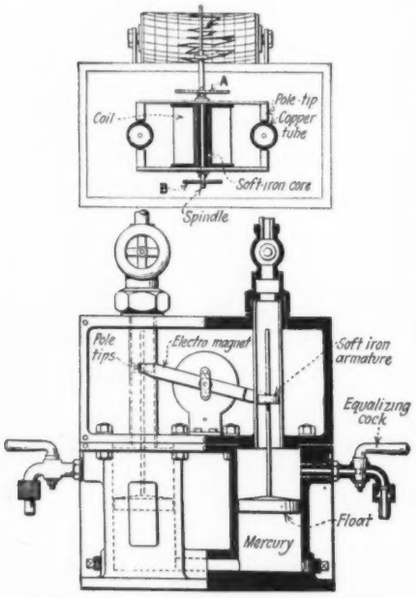


Fig. 1—Partial section of indicating and recording instrument

The general arrangement of the instrument is shown in Fig. 1. What, in effect, forms a U-tube is made by coring out two similar vertical cylinders in a cast-iron base and connecting them together at the bottom. Riding on the surface of the mercury in each cylinder is a float, from which projects upward into a tube, made of copper or other non-magnetic metal, a vertical rod on which is fixed a circular disk of soft iron. These disks are made to move freely inside the tubes. The lower end of each tube is sealed into a metal cap, which, when bolted in position on the base, hermetically closes the cylinders in the latter and brings the center of each tube immediately over the center of its corresponding cylinder in the base. The top of each tube is furnished with a valve, and from these two valves tubes are taken to the points at which it is desired to make measurements.

An essential feature of the apparatus is an electromagnet, which is arranged with its axis horizontal and furnished with a central soft iron core carried in bearings and free to oscillate. To the ends of the spindle are fastened strips of soft iron, fitted at right angles with soft iron tips arranged to come as close to each side of the tube as possible without touching. The core, strips and pole pieces, together with the soft-iron disks inside the copper tubes, form, when the electromagnet is energized, two very nearly closed magnetic circuits, and any vertical movements of the armatures in the tubes are directly and accurately reproduced in the circular movement of the core of the electromagnet, and hence in the pointers of the instrument, since the magnetic circuits will always tend to keep as short as possible.

The instrument, as illustrated in Fig. 1, is intended to act both as an indicator and as a recorder. The movement of the magnet core is transmitted to the indicating pointer and the recorder arm by gears on each end of the core spindle. The movement required for the recorder arm is not so great as that necessary for the indicating pointer, hence the gears on the spindle are of different diameters.

To remove any chance of sticking or sluggishness of the mechanism, brought about by friction or magnetic effects, a current interruptor is introduced into the circuit of the electromagnet, the effect being to increase the sensitiveness of the instrument. The interruptor consists of a solenoid-operated plunger which is arranged to move up and down automatically, with a certain length of stroke, and in so doing to open and close the circuit of the energizing electromagnet coil of the manometer. The frequency of the pulsations can be regulated by cushioning the action of the plunger, which operates as a piston inside the solenoid.

As has been said, the instrument was fundamentally designed for the measurement of the flow of steam—also of gas, water or other fluids—which it does by indicating or recording small pressure difference produced by such flow on either side of an orifice, Pitot tube or equivalent device inserted in the pipe through which the fluid passes. The arrangement of a combined indicating and recording manometer applied to a steam or water pipe is shown in diagram *A* in Fig. 2. In diagram *B*, Fig. 2, is shown the method of connecting the instrument for indicating boiler-water levels.

For giving indications at a distance away from the manometer, an arm fitted with a contact roller is connected to the magnet spindle. The roller, in turn makes contact with a small resistance coil mounted on a flat, insulated former. By varying the position of this contact, as happens when there are movements of the magnet spindle and indicating pointer, corresponding movements are obtained on a ratio-coil type of indicating instrument, the electrical connections of this transmitting arrangement being as shown in diagrams *B* and *C*, in Fig. 2. The diagram *C* shows the adaptation of the manometer for measuring the depth of liquid in a tank. In this arrangement one side of the instrument is connected, by means of a rising pipe, to avoid air lock, to any convenient point below the bottom of the tank. The oil-sealing reservoir, which is connected to the other side of the instrument, is so arranged as to compensate for the distance at which the manometer is fixed below the level of the tank.

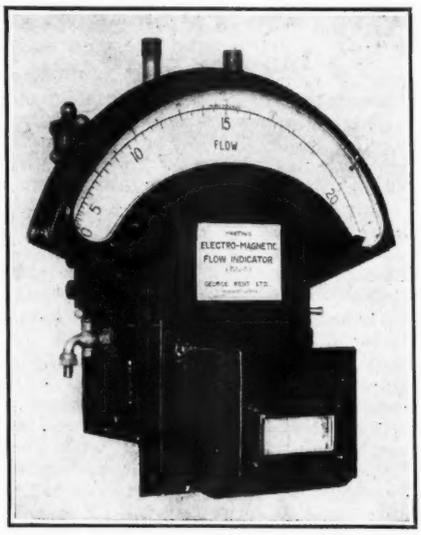


Fig. 3—Combined indicating and recording instrument

For use when dealing with boiler-water levels the indicator is also equipped with a simple electric high- and low-water alarm. This device consists of contacts, attached to the indicator pointer, one of which closes a circuit when the pointer reaches the extremity of its range in one direction, while the other acts similarly when the other extremity is reached, lamps of different colors being illuminated as one or other limit is reached.

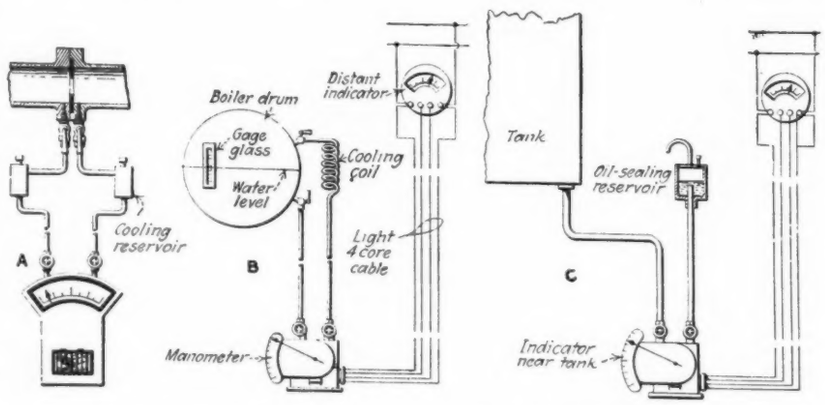


Fig. 2—Applications of the manometer and distant indicator

The instrument has been designed and patented by Harold Martin, of Portsmouth, and is manufactured by Messrs. George Kent, Luton, England.

A.I.E.E. Holds Power Plant Session at Annual Convention

FROM April 13 to 17 at Hotel Chase, St. Louis, Mo., the American Institute of Electrical Engineers held its spring convention. Attendance was up to standard, the registration showing a total of 700. A diversified program had been divided into seven technical sessions on power plants, power systems, machinery, communication, marine applications, mining and industrial applications. Two afternoons were reserved for inspection trips to Cahokia Station and other plants of engineering interest or for sight-seeing trips to places of general interest in and about St. Louis.

Of greatest interest to *Power* readers was the power-plant session on Monday afternoon, at which a paper on the Trenton Channel Station was presented by C. F. Hirshfeld, of the Detroit Edison Co., followed by informal discussion on the mechanical and electrical features of a number of the recent stations such as Philo, Weymouth, Cahokia, Richmond Station of the Philadelphia Electric, fuel-preparation plant of the Miami Fort Station, Hudson Avenue Station and comment on the new well type furnace for powdered coal which has been on test for some time in the Sherman Creek Station of the United Light & Power Co.

Trenton Channel Plant

In his paper on the Trenton Channel Plant[1] which had been planned for an ultimate capacity of 300,000 kw. in six units, C. F. Hirshfeld reviewed the characteristics of the territory and the system by which the new plant is interconnected with the several other stations of the company. Attention was called to the leading features of the design and the equipment in the station such as the 29,000 sq.ft. boilers, the powdered coal handling and preparation plant, the Cottrel precipitators for separating the fire dust from the hot gases, the 50,000-kw. single-barrel turbines and the regenerative cycle on which the plant operates, layout of the condensate system, the use of direct- and alternating-current drives for auxiliaries and the provision of separate condensing turbo-generators to supply the energy and finally the arrangement of the electrical end of the plant. Included in the paper were a summarized tabulation of major equipment and a complete motor schedule for the plant.

In discussing the Philo Plant, E. H. McFarland stated that at this time the American Gas & Electric interconnected system of eight stations with Philo in service consisted of 223,000 kw. of prime movers and high capacity interconnections with seven other power systems having 1,297,000 kw. of generation. The generating equipment that may operate in parallel aggregates 1,500,000 kw. and completion of line construction will double these values during 1926. The major system is 132,000-volt transmission for the planned service belt of approximately 700 miles extending from the southern part of Lake Michigan to southwestern Virginia, and to the Pennsylvania line. Philo, about ten miles south of Zanesville, Ohio, is situated central to this activity and at the western edge of the southeastern Ohio coal fields. With an abundance of fuel and base load obtainable for the plant, the limitation of development of the site proves to be condensing water from the Muskingum River. Using a 10-ft. difference in water level created by a government navigation dam at the plant site, it has been possible to take water from above the dam through the condensers and discharge into the lower pool without operating circulating pumps during periods of normal river flow, or probably eight months in the year.

A steam pressure of 550 lb. at the turbines with 725 deg. F. temperature, this steam to be withdrawn in turn from the turbine at 150 lb. pressure and reheated to 725 deg. F. and returned to the turbine, was selected as being the most advanced practice manufacturers and engineers would endorse in 1922, when construction began.

At 248 per cent boiler rating the gas temperature at the boiler outlet of 582 deg. F. is reduced through the economizers to 336 deg., and on the four boilers equipped with air preheaters is further reduced to a stack temperature of approximately 226 deg. F.

The first of the reheat boilers has been in service six weeks. During operation a number of varied operating contingencies have occurred and the facilities of control in meeting the emergency had functioned well. In all instances the reheated steam temperature fluctuation was maintained within 5 to 10 per cent of the established value.

As yet there has been no opportunity to make tests for economy in accordance with accepted codes, but with a full complement of station meters, it is the belief that at the full load of 40,000 kw., without steam extraction, the water rate of the turbine is 8 lb. per kw.-hr. when supplied with steam at 550 lb. gage, 725 deg. F. and reheated to 725 deg. F., and exhausting against 1 in. back pressure. The improvement with reheat is about 12½ per cent, which involves the addition of approximately 8 per cent more heat in the steam as against operating without reheat. The heat input to the turbine per kilowatt forms an unusually flat curve over a wide range. With temperature and pressure conditions of supply and reheating temperature maintained constant, at 40,000 kw., taking the value as 100 per cent; at 30,000 kw., the heat input value is increased ½ per cent per kw.; at 20,000 kw., 3½ per cent, and at 10,000 kw. 15½ per cent, all above full load value. The pressure at which reheating is done in this cycle varies from 50 lb. at 10,000 kw. to 155 lb. at 40,000 kw. The pressure drop or loss in withdrawing steam from the turbine, reheating and returning it to the turbine is approximately 5 lb. at full load conditions. This performance is indicative that for the combination at Philo, reheating the steam is a desirable operating condition from one-quarter load to full load. There is no difficulty in operating the reheating boiler in this range. Further, the arrangement has merit in meeting load conditions of variable character or lower load factor than at Philo.

The over-all performance of the plant may naturally be expected to improve as construction activities are finally brought to a close and the operating conditions and apparatus are tuned up. As typical of the present situation, for the week ending April 4, with 90 per cent load factor and average turbine load of 33,600 kw., the plant produced a net kilowatt-hour for 14,500 B.t.u., including transformer losses to the 132,000-volt feeders. Auxiliary uses were 4.15 per cent of generated value. With regard to capital costs expenditures of between $5 and $10 more per kilowatt of installed capacity have been made than if the plant had been constructed according to current lower steam pressure and temperature practice.

Weymouth Plants

For details of the Weymouth Station at Boston, I. E. Moultrop referred the convention to descriptions in *Power*[2] and the *Electrical World*.[3] With numerous slides he reviewed briefly the main features of the station and answered three questions that had been asked relative to the use of stokers rather than powdered coal, why 2,300-volt induction motors had been used for auxiliary drive and the advantages of the 1,200-lb. boiler. A lengthy study had shown that in this case there was nothing to do but stick to stokers. In Boston the most economical fuel to burn was the highest grade, most expensive coal. Freight charges on ashes could not be allowed nor the additional expense of pulverizing the fuel.

As to motors, 2,300-volt motors did not cost any more than 500-volt machines and money was saved in conduits and in floors of less thickness.

The expensive regenerative and reheat cycles did not fit in Boston, as they had no base-load plant and were thankful to get a load factor of 40 per cent. They wished something better than the standard 300- to 400-lb. station, so tried the 1,200-lb. boiler plan, which has been given previous publicity. This plan fits a station that has to operate on a poor load factor, as it is possible to go as the base-load demands with the 1,200 lb. and eliminate the higher pressure when desirable. The cost of such a station is less than for a standard 300 lb. installation.

H. W. Eales pointed out the basic features of Cahokia Station[3] in St. Louis, details of which have been given pre-

[1] For a detailed description see *Power* May 13, 1924.

[2] *Power*, April 14, 1925, *Electrical World*, April 18, 1925.

[3] *Power*, Jan. 22 and April 22, 1924.

viously in these columns. The building is being constructed in unit sections, each containing two main turbo-generators with the corresponding boiler and switchhouse equipment. At present two building sections have been completed and the foundations completed for Section III. These 35,000-kw. turbo-generators are in operation and a 40,000-kw. unit is nearly ready for operation. Twelve 18,000-sq.ft. boilers burning pulverized fuel are in operation at 330 lb. gage pressure, and four more of the same size are being installed. In view of the relatively low-priced fuel no air preheaters nor economizers are used.

In operation the station has had the usual temporary difficulties incident to installations while new, but at no time has the pulverized-fuel installation caused any interruption of the service from the station. Operating results in the station from Jan. 1. 1924, to March 1, 1925, are given in the accompanying table.

Differences in Design of Trenton Channel and Cahokia

C. G. Spencer had been asked the reasons for certain differences in the basic design of Trenton Channel and Cahokia, such as the precipitation of ash from the stack gases, the separate preparation plant, the large Stirling-type boilers fired from both ends, direct current for variable-speed essential auxiliaries and single-pass condensers. A survey of controlling factors showed the quality and cost of coal normally available at either plant to be the factor of widest divergency. Next in importance was the physical condition of the sites, Trenton Channel being in a residential district and Cahokia in a location given over largely to railroad yards and industry, hence ash precipitation in one case and not in the other. At Cahokia the unusual combination of flood and foundation conditions made projected area rather than height the controlling factor in keeping costs down. This was one reason the preparation plant was included in the boiler-house structure, and another was the necessity of drying Illinois coal every day in the year, requiring waste-heat driers in near proximity to the boiler uptakes.

Alternating current was selected for auxiliary drive, as it resulted in lower first cost and combined the required speed variation with a reliable supply. The single-pass condenser did not lend itself to the deep pit construction at Cahokia required by a 40-ft. variation in river level. Owing to local conditions the two-pass condenser was lower in first cost.

E. H. Tenney gave the cost of operating and maintaining the pulverized-fuel equipment at Cahokia during the last 12 months of operation, and some details on the operation of the 15-ton and 20-ton mills recently installed. The cost of preparation of pulverized coal at Cahokia, including all costs from the receipt of coal in the yard to the removal of ash from the ashpits, and also including power for driving the necessary auxiliaries, was 33.58c. per ton. Of this the handling and preparation of raw coal cost 6c. per ton; the drying, handling and preparation of powdered coal, 19c. per ton, and the power for all purposes, 8.58c. per ton.

The power required for handling coal was made up as follows:

	Kw.-Hr. Per Ton
Unloading, conveying and crushing	0.4
Power for drier fans	2.66
Mills and mill fans	16.15
Air compressors	6.48
Total	25.69

It is anticipated that these figures will be reduced 4 kw.-hr. per ton by the use of the 15- and 20-ton mills.

It will be understood that these data are the actual figures that prevailed during the last 12 months and do not take into account what the cost might have been had the load factor on the equipment been up to the maximum.

Tests on the Raymond 6-ton mills gave the following performance:

Tons pulverized per hour	6.85
Kw.-hr. per ton	17.4
Moisture in coal leaving mill per cent.	5.3
Gas temperature inlet, deg. F.	400
Gas temperature outlet, deg. F.	165

Fineness. 65 per cent through 200 mesh screen

On the 15-ton Raymond mills, which have been in operation for 10 months, the following figures taken from a test are available:

Tons per hour	16.3
Kw.-hr. per ton	15.0
Moisture in coal entering mills, per cent	9.8
Moisture in coal leaving mills, per cent	4.7
Temperature of gases entering drier, deg. F.	465
Temperature of gases leaving drier, deg. F.	160

Fineness of coal
66.75 per cent through 200-mesh screen

A preliminary test on the Fuller 20-ton mill which has now been in operation about four months, gave the following results:

Tons per hour	23.5
Kw.-hr. per ton	14.6
Moisture in coal entering mill, per cent	10.0
Moisture in coal leaving mill, per cent.	4.5
Temperature of gas entering drier, deg. F.	340
Temperature of gas leaving drier deg. F.	150

Fineness of coal
62½ per cent through 200-mesh screen

The lower gas temperature noted in the driers of the Fuller mills is due to the difference in design of the drying equipment, which has resulted in the passing of more gas through the driers.

Air required for transporting powdered coal about the station is now running approximately 1,600 cu.ft. per ton.

During the past year the lubrication of the milling equipment, which has been referred to frequently as an item of some importance, has amounted to 0.6c. per ton of coal.

Earl Hopping, of the Philadelphia Electric Co., outlined Richmond Station, which is to have an ultimate capacity of 600,000 kw. in twelve 50,000-kw. units and compared it with Trenton Channel. Coal comes in by rail and is dumped into barges for delivery to the plant to eliminate switching charges. Studies had indicated that with preheated air the cost of operating a stoker plant, including all overhead and operating expense, would be as low as with pulverized fuel. High-grade coal was available, and as the plant was in a good location they could not afford to distribute ashes over the neighborhood.

Single-ended boilers were used, as both air preheaters and economizers had been employed, the combination being used rather than a full preheater installation, as they were afraid of the temperatures that might result. With the present operating air temperature of 325 deg. F. results are entirely satisfactory. Taking into account all factors, the steam pressure and temperature considered most economical were 400 lb. and 700 deg. F. Materials available had set these limits.

Single-cylinder tandem-compound turbines had been used, as they permitted more light and better visibility in the basement where the auxiliaries were located. With a large number of the auxiliary services adopted for constant speed, alternating-current motors were used as they were cheaper and more economical.

F. A. Scheffler showed a number of slides and commented on the features of the pulverized-fuel equipment of the Miami Fort Station near Cincinnati. A feature was the use of both vertical and horizontal burners. Hollow ventilated furnace walls were used in preference to water screens.

H. W. Brooks made reference to a new method of burning powdered coal which would reduce furnace volumes to that of the old-time stoker plant and bid fair to revolutionize the industry. The arrangement was a small circular well-type burner furnace arranged on the tornado plan with a mixing chamber above. In modern stoker installations 18,000 to 24,000 B.t.u. were released per cubic foot of furnace volume. In the well-type furnace the heat release ran to 750,000 B.t.u. per cu.ft. Efficiencies were 3 per cent higher than any one of five other methods and the economy curve flatter. For some time an installation had been under test at the Sherman Creek Station of the United Light and Power Co. and results soon would be available.

Louis Elliott expressed the opinion that the recent placing in operation of the Philo and Crawford Avenue plants, with the low fuel consumption reported, made of particular interest the decision for Trenton Channel to install 375-lb. turbines working on the regenerative cycle, as against a higher-pressure plant designed for reheat.

A recent estimate for a moderate-sized station indicated an excess cost for a 650- to 550-lb. reheat plant, as compared with a 425- to 375-lb. plant, of about 7 per cent. With a capacity factor of 60 per cent annual, this additional investment would entail an increased fixed charge around 0.3 mills per kilowatt-hour. Assuming that the 550-lb. plant would permit a saving in production cost equivalent to 10 per cent of the fuel cost, this saving with 10,000-B.t.u. coal at about 1.1 mills per pound in the pulverized-fuel bins would amount to between 0.15 and 0.2 mills per kilowatt-hour output.

For this situation the recommendation was made to install 425-lb. boilers with turbines good for 376 to 400 lb. On the foregoing basis coal would have to cost nearly double its present price to give an equivalent cost of energy for the two pressures. Aside from the estimated saving in combined fixed and production cost of energy, the lower-pressure equipment is more thoroughly developed and probably more reliable, and the 375-lb. regenerative plant would be more simple to operate.

In his reply to this extended discussion, Mr. Hirshfeld admitted that improvements had extended greatly the capabilities of the stoker over what they were when the decision was made to burn powdered coal at Trenton Channel. They were burning, however, a more varied quality of coal than would be economically possible with stokers. The boilers in the pulverized-fuel plant were driven at 350 per cent of rating. At no time had the double-ended boilers limited the capacity. The limitations were with the fuel-burning equipment on the furnace. With stokers the grate area and ability to maintain the walls determine the rating to which the boiler may be driven. Stokers were not built that gave uniformly high efficiencies over a wide range. The characteristic efficiency curve of the stoker sloped down, and the high point would be placed where most desirable.

Trenton Channel station had been designed to give a net kilowatt-hour of output on 16,000 B.t.u. when operating on a load factor of 50 per cent. In operation for the last six months the performance had improved weekly. Some weekly figures had dropped below 16,000 B.t.u. per kw.-hr., but the average was in this vicinity.

For the last three months the cost of preparing the coal, including every item of operating expense from the track hopper to the pulverized-fuel bunker, such as labor for operation and maintenance, all power, and the steam that may be used for drying the coal and heating the preparation house, averaged 30c. per ton pulverized. This was obtained in a plant using 8-ton mills and in a house designed to pulverize twice the amount with the same labor. When using the plant to capacity, the preparation cost should drop to something less than 22c. per ton.

Operating Horizontal Turbines*

Starting.

1. Notify switchboard operator that machine is ready to be warmed up.

2. After receiving affirmative reply, start the auxiliary oil pump and see that it is operating under correct pressure.

3. Start the circulating pump and air pump, giving proper attention to the priming of the circulating pump and the removing of air from the water side of condenser.

4. See that oil is circulating to all main bearings—check oil-filter operation.

5. See that the governor is being supplied with oil.

6. Rule to cover any trying out of speed control mechanisms while machine is stationary, should be made by the constituted authority, and inserted here.

7. Examine all gages and see that steam gages show proper pressure, vacuum gages show proper vacuum and oil and water gages show proper pressure.

8. Start the hotwell pump.

Note: Hotwell pump should be started when high water alarm signal operates, with discharge throttled to hold proper level of water above pump while warming up the turbine.

9. Turn on steam to turbine seals.

Note: Steam should be applied to seals just before starting up, so that no stresses will be set up by localized heating of stationary shaft.

10. See that all turbine drains are open.

Note: Open drains, when same will not seriously interfere with vacuum. In case draining and sealing are effected through the same line, rule to cover specific practice and equipment should be made by the constituted authority, and inserted here.

11. Open the throttle quickly until the first stage pressure gage registers (....) pounds.

12. As soon as the spindle starts rolling, close the throttle to point where machine's speed is at desired rate for warming up the unit.

Note: Vacuum during warming up process to be such that temperature through low-pressure portion of turbine will approximate temperature of operating conditions.

13. If specific practice is to trip throttle during starting up operations, rule to cover this feature should be made by the constituted authority, and inserted here.

Note: It is recommended that this rule be related to rules Nos. 11 and 12, so that tripping is effected when the valve has a small opening, as it is most conducive to sticking at this time.

14. Listen for internal rubbing until turbine goes into service.

15. With spindle revolving, turn on water to water seals.

16. Turn on cooling water to oil cooler and main bearings.

Note: Water valve to oil cooler should be cracked slightly after turbine is started to keep water circulating through cooler to prevent a sudden change of temperature in cooler. A close watch on oil temperatures will determine further regulations to oil cooler circulating water, and the time to turn on cooling water to main bearings.

17. When unit is warmed up notify switchboard operator that machine is ready for operating speed.

18. After receiving affirmative reply, open the throttle until the first stage pressure registers (....) lb. and maintain this pressure until the machine comes up to speed, which will be indicated by the closing of the admission valves by the governor and a reduction of the first stage pressure below normal starting pressure.

18a. If the machine is equipped with an oil pump operated off the turbine shaft, see that this pump goes into service as the machine comes up to speed and that the auxiliary oil pump slows down to a very slow but continuous speed.

18b. As the machine comes up to speed, watch for vibration and do not operate on critical speeds longer than necessary.

Note: This rule to be made specific by the constituted authority in accordance with turbine manufacturers' node data.

19. Open the throttle wide, noting that no increase takes place in the first stage pressure, or in the turbine speed as shown by the speed indicator.

20. Close the throttle valve until it is sufficiently in advance of the governor to carry the synchronizing load.

21. Notify the switchboard operator that the machine is ready for "load."

22. After receiving affirmative reply, synchronize the machine as quickly as possible and apply load up to (.....) kw.

23. See that vacuum is at a maximum.

24. Build up load on the machine at the rate of approximately (.....) kw. per minute.

Note: As the load comes on, the opening of the throttle valve should be gradually increased and kept in advance of the governor.

25. When machine is carrying approximately (.....) kw., open the throttle wide and regulate the amount of steam supplied to the seals.

26. Make general inspection of all gages and oil temperatures from all bearings.

Shutting Down.

1. After being notified by the switchboard operator that load is to be taken off the machine, stand by to regulate the sealing system as the load decreases.

2. Start the auxiliary oil pump by hand, to see that it will start properly.

3. After being notified by the switchboard operator to "stop" the machine, close the throttle slowly.

Note: If the specific practice is to close throttle with hand trip or oil relay while shutting down, rule to cover this operation should be made by the constituted authority and inserted here.

4. See that the auxiliary oil pump starts as the machine slows down, and that proper pressure is maintained.

5. Break vacuum when machine is approximately (.....) per cent below operating speed.

6. Shut off steam and water to seals.

Note: Do not shut off all the steam to seals until vacuum is destroyed, because of the harmful effect resulting from cold air being drawn through the seal glands.

7. After machine stops, shut off the oil and water supply to the main bearings and oil cooler.

Note: Temperatures will be a guide in shutting off the water to water cooled bearings.

8. Shut down the auxiliary oil pump.

9. See that the admission valves have been opened by the governor.

10. Make a general inspection of the turbine.

11. Lubricate admission valves with a high grade cylinder oil and a small quantity of graphite.

*From recent operating code of the Prime Movers Committee, N. E. L. A.

Austrian Power Plant Opened

The official opening of the Tegitsch Works in Styria, a large power station, took place on March 28.

This marks an important step forward in the network of general electrification and the utilization of water power throughout Austria. It is estimated that the development of water power will reduce the cost of electricity one-half by obviating the importation of foreign coal.

The Tegitsch power plant will have an output of 420,000 kw.

Recent Publications

Technical Mechanics — Statics, Kinematics (Fourth Edition, rewritten). By Prof. Edward R. Maurer and Assistant Professor Raymond J. Roark, both of the University of Wisconsin. Published by John Wiley Sons, Inc., New York City, 1925. Cloth; 6x9 in.; 359 pages; 118 illustrations. Price, $3.50 net.

The fact that this book has gone into its fourth edition proves its worth. It presents the subject in a substantial manner midway between the highly mathematical books on theoretical mechanics and the books generally entitled "Applied Mechanics." The mathematics required for its understanding includes the elements of calculus.

The Enlarged Callendar Steam Tables. By H. L. Callendar, prof. of physics in the Imperial College of Science and Technology, (England). Published by Edward Arnold & Co. (London), 1924. Handled in United States by Longmans, Green & Co., 55 Fifth Ave., New York City. Cloth; 5½x8½ in. Price, $2.50.

In these days of high pressures and low steam tables it is a pleasure to open a book giving steam data up to 2,000 lb. pressure and 1,000 deg. F. It should not be thought, however, that this extension represents new data. It is merely the product of simple formulas thermodynamically consistent and known to fit observed results at low pressures. When experimental results are obtainable, they may diverge considerably from the values given in the higher sections of the table. In addition to the main table this book contains a table of the properties of steam at low pressures with an entry for each tenth inch of vacuum. Special tables for computers are also included.

How To Build Up Furnace Efficiency ("in Five Stages of Amplification"). "Broadcast by Jos. W. Hays, combustion engineer, from Station PDQ., Michigan City, Ind." Seventeenth edition (revised and enlarged). Published by Jos. W. Hays and associates, Michigan City, 1924. Cloth; 5¼x7½ in.; 534 pages; numerous illustrations. Price, Malloy binding, $3.50; cloth binding, $3; flexible waterproof binding, $2.75.

The engineer, and particularly the "white collar" engineer, glancing over this book for the first time, may be a little shocked at some of the cartoons. They may strike him as rather rough and crude—about in line with the comic strip of the Sunday newspapers. The book is avowedly breezy both in text and pictures. That such a book meets a real need is evidenced by the fact that this is the seventeenth edition (the first was in 1908) and that 120,000 copies have been printed to date. This seems to demonstrate a real demand for a painless presentation of the subject of combustion. From start to finish the book is full of rough and ready humor. Yet a lot of real combustion information is inclosed between its covers. There is little question that this book has done and will continue to do much good in getting combustion principles across to those who rebel at the ordinary, rather dry presentation.

Employers' Representation in Steel Work. By Ben M. Selekman. Published by the Russell Sage Foundation, 130 East 22d St., New York City, 1924. Cloth; 5½x8 in.; 293 pages. Price, $1.50.

The Russell Sage Foundation has been conducting studies and investigation of the carrying out of new ideas in industrial relations, of which this study of the industrial representation plan of the Minnequa Steel Works of the Colorado Fuel & Iron Co. in one, for some years. Study of the working out of this, the Rockefeller plan, in the steel industry was begun in 1919 and continued until 1924 as frequent references show. It should be of value to those wishing to arrive at a better understanding of labor problems in industry as it considers both good and bad features of the experiment.

John Edson Sweet. By Albert W. Smith. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City, Cloth; 6x9 in.; 220 pages; illustrated. Price, $5.

To John Edson Sweet more than to any other individual does the American Society of Mechanical Engineers owe its conception and organization. It is fitting therefore that among the biographies of great American engineers, the publication of which it is fostering, should be included that of the man through whose activity it was founded, who wrote the first paper that was presented before it and who served as its third president. It is fitting, too, that the biography should be written by the Dean Emeritus of Sibley College, where the subject of the story, as "Master Mechanic and Director of the Machine Shop" and afterward as "Professor of Practical Mechanics and Director of the Machine Shops," exerted so great an influence in the training and formation of so many young men who have won fame in and added to the achievements of the profession.

The treatment divided into two parts, the first of which introduces "The Man," reviews his "Heredity and Early Life," takes him through his training "In Europe and Syracuse" and his teaching "At Cornell," tells of the organization of "The Straight Line Engine Company," the part played by Professor Sweet in the "Development of the Soda Industry in the United States," "The Founding of the A.S.M.E.," and "Professor Sweet's Boys and Their Annual Dinner." The second part is a compilation of excerpts from his addresses and letters. Appendices treat of some of his own and collateral work in more detail. It is a simple story, well told, of a simple life well lived.

Patents: Invention and Method. By Harold E. Potts. The Open Court Co., 149 Strand, London, W.C.2, 1924. Stiff paper back; 5x7¼ in.; 160 pages.

A collection of papers presented before the Chartered Institute of Patent Agents and appearing in *Nature* and *Chemical Age* are here reprinted. They are interesting and useful discourses on topics involved in the getting of patents, that is, the language, and style in patent law, the problems of definition, scientific method and patent practice.

Vibration in Engineering. By Julius Frith, M.Sc., Member of the Institution of Electrical Engineers of the Institution of Civil Engineers, Associate Engineers and Frederick Buckingham, B.Sc. (Eng.) Associate of the City Guilds Institute, Associate Member of the Institution of Civil-Engineers, Associate Member of the Institution of Mechanical Engineers. Published by Macdonald & Evans, 8 John St., Bedford Row, W. C. 1, London, England, 1924. Cloth; 5½x8½ in.; 123 pages; 41 illustrations. Price, $1.80, (7 shillings 6 pence.)

The physical and mathematical sides of vibration are put forward for the benefit of the manufacturer's engineer, in order that vibration troubles may be avoided. A list of symbols precedes the text. Vibration of many kinds is described, and the analytical side then taken up. Numerous examples, together with a clear, readable text, are employed for the treatment of many types of vibration, such as that of the pendulum, shafts in torsion, bending of elastic beams, whirling shafts, etc. A reader desiring to go straight to the point with least effort will find this volume of great assistance.

Steam Power-Plant Engineering. By G. F. Gebhardt, professor of mechanical engineering, Armour Institute of Technology. Sixth edition (rewritten). Published by John Wiley & Sons, New York City, 1925. Cloth; 6½ x 9½ in., 1036 pages; 714 illustrations. Price, $6 net.

In the whole field of power-plant books there probably is no title better known to American engineers than "Steam Power Plant Engineering," by Gebhardt. To those who learned to depend upon the previous edition for information on a variety of subjects, it has been a source of disappointment to see much of its contents become almost obsolete with the recent rapid progress made in the power field. The present edition remedies this situation. A thorough revision has brought it into accord with more recent practice. This is evident not only by a great amount of new material in the chapters on combustion, steam boilers, furnaces, reciprocating engines, steam turbines, condensers, etc., but by the introduction of new subjects, such, for example, as evaporators. Some interesting cost data, fairly recent, are included in the chapter on Finance and Economics—Cost of Power. The great size of this volume makes it impracticable, in the space available, to give even a faint idea of its contents. It must suffice to say that practically the whole field of steam power-plant engineering is covered.

Muscle Shoals Commission To Take Up Individual Study of Problem

President Wants a Fresh Start Made—Written Views Invited—Waldo and Murray Added to Commission

THE PRESIDENT has given a free hand to his Muscle Shoals Commission. During the course of his first conference with the Commission on April 9, he is understood to have told its members to wipe the slate clean and take a fresh start in the hope that the way may be pointed to the best solution of the matter, which he feels has been delayed far longer than any problem involved warrants.

He is said to have been emphatic in his attitude that he desires the Commission to approach the problem untrammeled by any instructions from him, although he pointed out that there is more involved than the disposition of the properties and the power. His reference is interpreted by some to mean that this property has been made the battle ground for a struggle between those who favor public operation and those who favor private operation of such utilities.

After discussing some of the general phases of their work, the members of the Commission returned to their homes to take up individual study of the problem. Formal announcement was made of the Commission's desire to receive in writing any views having a bearing on the disposition of the government's properties. Five copies of each communication are requested, so that each Commissioner may be supplied with one. Specific requests for expressions of opinion will be sent out to the Southeastern power companies, Henry Ford and others who have made studies of the possibilities of the project. By securing written statements, the Commission hopes to avoid the holding of public hearings.

President Appoints Expert

Under the provisions of the National Defense Act, which authorizes the employment of experts and others needed in connection with the Muscle Shoals development, the President has appointed W. G. Waldo as the Commission's technologist and W. E. Murray to be secretary of the Commission. Mr. Waldo is a civil engineer, a graduate of the Massachusetts Institute of Technology, who has been associated with the project since its inception, as engineer for the Tennessee River Improvement Association. During the war Mr Waldo was in the service of the Ordnance Department. He was district supervisor for the Muscle Shoals district.

After receiving its instructions from the President, the Commission established its headquarters in the rooms of the Military Affairs Committee in the House Office Building. The Commission conferred with acting Secretary of War, Dr. Ball, the director of Research for the Department of Agriculture, and Dr. Cottrell, the Director of the Fixed Nitrogen Laboratory of the Department of Agriculture. Secretary Hoover was invited to confer with the Commission, but he suggested that his appearance be delayed until the Commission had progressed further with its study.

Leasing Power on Temporary Basis Opposed

When Secretary Davis told the Commission that the War Department is planning to lease the power on a temporary basis pending its final disposition by Congress, determined objection is understood to have been voiced by one of the members of the Commission. His thought was that the power once leased could be called back only under great difficulties. The point also was made that Congress would act more promptly on the whole question were the disposition of power held in abeyance. During four hours of discussion the other side of the question was developed. The point was made that it would not be in accordance with the spirit of the President's economy program to allow this power plant to stand idle when the output could be sold readily for $1,500,000 or $2,000,000, for a period which would include two low-water seasons. In addition the government would be relieved of an expense of $500,000 for maintenance.

An investigation made on behalf of the Secretary of War discloses that the power can be sold on an eighteen-months' contract, with a clause providing for termination at any time during the life of the contract on thirty days' notice, for at least $1,500,000. Colonel Spaulding, the engineer officer in charge of the work, believes that $2,000,000 can be obtained for it. Owing to the recent drought in the Muscle Shoals region, there is a scarcity of power there, it is reported.

In his letter to the Commission, Mr. Davis stated that the Department would proceed with the operation of the first unit in July and the three other units in January unless Chairman Mackenzie and his associates decided that such operation would interfere with their deliberations.

Gen. Harry Taylor, the Chief of Engineers, states that he has no reason to revise his estimate that the Corps of Engineers' part of the work will have been completed July 1. In fact, water can be turned on the wheels at this time. The limiting factor is the installation of a switchboard. The General Electric Co. promises, however, to have that installation ready by August 1, which means that all the power that can be developed will be available on that date. It is realized that all this power cannot be put to work at that time as some adjustments of new machinery always are necessary.

Joint Engineering Board Meets

The Joint Engineering Board, composed of American and Canadian engineers who are studying the St. Lawrence project, met in informal sessions in Montreal the week of April 14. The object of the meeting was to correlate plans for the engineering investigations that will be conducted this summer on behalf of each country. Advertisement has been made in Detroit of the request for bids to do the boring which will be undertaken under the direction of the American members of the Board.

Big Creek No. 2's Fourth Unit Put To Work

On March 31 a fourth generating unit of 17,500 kva. was placed in operation at Big Creek plant No. 2, of the Southern California Edison Co. The unit is of the horizontal type and is driven by a 22,000-hp. Pelton impulse waterwheel operating under a head of 1,680 ft. Precipitation in the Big Creek territory this year continues above the average, and it is expected to carry the major portion of the system load on the hydro plants, using only the new units recently installed at the Long Beach steam plant for block steam power.

Canadian Power Tax Will Yield $315,000

The new tax of $1.95 per horsepower on electric current exported from Canada, as provided in the new Canadian budget, was estimated recently to yield $146,250 in Quebec and $168,267 in Ontario. The only company exporting from Quebec is the Montreal Light, Heat & Power Consolidated and its affiliated companies. Last year two Ontario companies, Ontario Power Co. and the Toronto Power Co., now subsidiaries of the Ontario Hydro-electric Power Commission, exported 52,204 and 34,087 hp. years respectively.

Franklin Institute Presents Medal to Hodgkinson

The Elliott Cresson gold medal, one of the highest honors conferred by the Franklin Institute, was presented to Francis Hodgkinson, chief engineer of the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co., in the presence of a large and distinguished audience at the old Franklin Institute building, April 15.

The presentation was made by William C. L. Eglin, president of the Institute, at a meeting which was preceded by a private dinner at the Bellevue Stratford Hotel. The award was made to Mr. Hodgkinson in recognition of his achievements in the field of steam-turbine design and construction during the past thirty-one years.

Mr. Hodgkinson, who was born in England, received his primary education at the Royal Naval School at New Cross, London. In 1885 he joined C. A. Parsons & Co., the world-famous turbine engine company, remaining with this company until 1890, during which time he was engaged in steam-turbine work, first as machinist, later as draftsman, and finally superintendent of field work.

Going abroad in 1890, Mr. Hodgkinson spent four years in South America. At the end of that time he rejoined C. A. Parsons & Co. as general foreman of erecting and fitting shops. The following year the Westinghouse Machine Co. secured the American rights for the manufacture of the famous Parsons-type turbines. In 1896 Mr. Hodgkinson, upon the recommendation of the Hon. C. A. Parsons, became connected with the Westinghouse Machine Co., taking charge of the engineering works and designing of the Parsons-type turbines. This position he still retains and in addition since 1916 has been acting as chief engineer in charge of all the engineering departments of the South Philadelphia Works. Practically all the commercial steam turbines built by this company have been largely originated by him and designed under his direction.

Hetch Hetchy Power Will Be Distributed by Agencies

Unanimous approval was given by the Board of Supervisors of San Francisco at a meeting on April 13, to a plan to dispose of Hetch Hetchy power through the agency of the local power companies. The agency plan was proposed a week earlier by an advisory committee as the only feasible solution of the problem of disposal of the city's power until such time as the people of San Francisco shall have acquired a municipal distribution system or decided what shall ultimately be done. This action followed the failure of the city to receive any bids from municipalities or irrigation districts for the temporary purchase of the power. A special committee has been appointed to negotiate with the power companies to distribute the energy from the 80,000-kw. Moccasin power plant, which will be available at Newark, thirty miles from San Francisco, in about sixty days.

The city engineer, it was stated, has been informally offered approximately $2,000,000 a year for the power by the private corporations. The advisory committee report approved the Supervisors' recommendation that some plan be agreed upon whereby the city can lease facilities from one of the local companies on a flat rate basis and sell power to the city's own consumers. A provision was included that any agreement entered into must be in conformity with the provisions of the Raker act under which San Francisco came into possession of the Hetch Hetchy water rights. This act provides that the power cannot be sold to any private corporation for resale. The new plan is believed to meet this provision.

Francis Hodgkinson receives gold medal from Franklin Institute

Brussels To Hold Centenary Exposition

An International Exposition will be held in Brussels in 1930, according to press notices, to celebrate the centenary of Belgium's independence. It is announced that of the 25,000,000 francs needed, 17,000,000 has already been subscribed.

Extra Copies of Diesel Power Plant Insert Available

In case any of *Power's* readers desire an extra unfolded copy for framing of the Diesel Power Plant, which is published with this issue of the magazine, it may be obtained gratis as long as they last, by addressing the Editorial Department of *Power*, 10th Ave. at 36th St., New York City.

Permit To Develop Colbert Shoals Asked

The Southern Power & Light Co., a newly formed subsidiary of the Arkansas Power & Light Co., has applied for a preliminary permit covering a proposed project at Colbert Shoals on the Tennessee River. This site is eleven miles below Muscle Shoals. It is proposed to construct a dam 45 ft. high near the town of Waterloo. It is the intention of the applicant to install 100,000 hp. of generating equipment.

Coincidental with the filing of the application the applicant announced that this is to form a part of an inter-connected system to cover Arkansas, Louisiana and Mississippi. It also was intimated that the Couch interests would attempt to secure power from Muscle Shoals to feed into that system. The proposed project at Colbert Shoals is to be connected with the lines of the Mississippi Power Co., the Louisiana Power Co. and the Arkansas Light & Power Co., the applicant states.

Power On Lakes-to-Gulf Waterway Uncertain

M. G. Barnes, chief waterway engineer for Illinois, believes according to press reports, that the legal obstacles halting the construction of the Lakes-to-the-Gulf Waterway through Illinois have practically been removed by a recent court decision, and that building may be resumed in June. Funds needed are available, it is stated. The tallest barriers in the path of the waterway were cleared and the linking of the Great Lakes with the Mississippi system might be completed within three years, he said.

The recent decision of Secretary Weeks, progressively limiting the amount of water diverted from the Lakes system at Chicago down the sanitary canal, threw an element of uncertainty into the power developments along the waterway. Mr. Barnes said that the state had a permit to develop all the water not needed for navigation, but that it was embarrassed in planning for the amount that would be permanently available.

Dinner in Honor of Swasey Announced

The Engineering Foundation Board will, in connection with its regular meeting, May 14, take advantage of the occasion, which is the tenth anniversary of the first meeting of the Board, to honor Ambrose Swasey by entertaining him at dinner at the Union League Club, New York City. Those invited to the dinner are the trustees and officers of the United Engineering Society, the directors, the presidents and the secretaries of the Founder Societies and the members and officers of the Foundation Board.

Water Power of the World End of 1923

The developed water power of the world in 1920 was about 23,000,000 hp., according to an estimate made by the United States Department of the Interior in 1921 through the Geological Survey. At the end of 1923, according to the best information available, it was about 29,000,000 hp., an increase of 26 per cent in about three years. The increase was about 1,500,000 hp. in North America, 3,400,000 in Europe, and 1,000,000 in Asia. Europe as a whole has passed the United States in the rate of development of water power, which has been forced on all the industrial countries except Great Britain by the high price of coal. The increase in the production of electricity by water power in the United States for the same three years was about 20 per cent. The development of water power in the United States, although it is now going forward more rapidly than ever before, shows a percentage of increase less than that in Canada, Europe and Japan and in the world as a whole. The continents have the following figures:

Divisions	Developed	Potential
North America ...	13,700,000	66,000,000
South America	675,000	54,000,000
Europe	12,300,000	57,000,000
Asia	2,000,000	69,000,000
Africa	14,000	190,000,000
Oceanica	220,000	17,000,000
Approximate total	29,000,000	453,000,000

In North America the United States leads in that her developed water power is 10,000,000 hp. and potential 35,000,000 hp.; Canada is second with developed 3,227,000 hp. and potential 18,250,000 hp.; Mexico is third with 300,000 hp. developed and 6,000,000 hp. potential.

In Europe, France heads the list, with 2,100,000 hp. developed and 5,400,000 potential; Norway is second, with 1,820,000 hp. developed and 9,500,000 potential; Italy is third, with 1,800,000 developed and 3,800,000 potential, Italy has developed a greater proportion of her water-power resources than have the other countries of Europe; Sweden is fourth with 1,416,000 developed and 8,000,000 potential; Switzerland is fifth, with 1,490,000 hp. developed and 2,500,000 potential; Germany is sixth, with 1,100,000 developed and 2,000,000 hp. potential.

In Asia, China has 1,650 hp. developed and 20,000,000 potential; India has 197,000 hp. developed and 27,000,000 potential; Siberia has 90,800 developed and 8,000,000 potential; Japan has 1,694,000 hp. developed and 4,500,000 potential.

In Africa the Belgian Congo and Belgian mandate have 250 hp. developed out of potential 90,000,000 hp.

Detailed figures of the developed and potential water powers of the different countries may be had from the Geological Survey, Washington, D. C.

Output of French Coal Mines Increases

During the month of January 1925, the French coal mines output amounted to 4,171,595 tons for 26 working days, as against 3,850,335 tons for 25 working days in December, 1924. This monthly output is the highest ever reached. The coal mines of Lorraine produced 18,645 tons daily during the month of January.

New York State Can Now Sell Barge Canal Power

The recently closed legislature of the State of New York passed an amendment to the law which authorized the development of hydro-electric power at points along the Barge Canal, which amendment authorizes the state officials charged with the disposal of surplus power to sell it to the highest bidder. This action clears up the situation in which these officials found themselves following the action of the previous legislature restricting the sale of this power to municipalities only, when no municipalities would purchase the power because of its character or because they were already committed to the purchase of other power by contract.

Regional Meeting of A. I. E. E. Program

The program of the Regional meeting of the A.I.E.E., which is to be held at the New Ocean House, Swampscott, Mass., May 7-9, contains papers of interest to *Power* readers as follows:

"Sleet and Ice on Transmission Lines," by C. R. Oliver, New England Power Co.

"Tap Changing Under Load," by H. C. Albrecht, Philadelphia Electric Co.

"Voltage Control Obtained by Varying Transformer Ratio," by L. F. Blume, General Electric Co.

"Changing Transformer Ratios Without Interrupting the Load," by M. H. Bates, General Electric Co.

"Universal-Type Motors," by L. C. Packer, Westinghouse Electric & Manufacturing Co.

"A Two-Speed Salient-Pole Synchronous Motor," by R. W. Wieseman, General Electric Co.

"Co-operative Course in Electrical Engineering," by Prof. W. H. Timbie, Massachusetts Institute of Technology.

"Education in Industry," by S. W. Ashe, General Electric Co.

"Recent Improvement in A-C Indicating Instruments," by S. H. Hoare, General Electric Co.

"Measurement of Electrical Output of Large A-C Turbo-Generators," by E. S. Lee, General Electric Co.

"Temperature Errors in Induction Watt-hour Meters," by I. F. Kinnard and H. T. Faus, General Electric Co.

Navy Opens Bids On Coal for Lakes Naval Hospital

Bids opened April 8 by the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for 8,000 tons of bituminous screenings and 1,500 tons, run of mine bituminous coal for delivery at the United States Naval Hospital, Great Lakes, Illinois, during April and May, were as follows:

Eight thousand gross tons bituminous screenings: J. K. Dering Coal Co., Chicago, $2.24 per ton, f.o.b. mines, $4.67 delivered; Great Lakes Coal & Coke Co., Chicago, $1.55 f.o.b. mines; Great West Coal & Lumber Co., Chicago, $2.24 f.o.b. mines; O'Gara Coal Co., Chicago, $2.12 f.o.b. mines; Peabody Coal Co., Chicago, $2.13 f.o.b. mines; Sterling Midland Coal Co., Chicago, $2 f.o.b. mines; Wade Coal Co., Chicago, $2.02 f.o.b. mines, $4.025 delivered.

One thousand five hundred gross tons run of mine bituminous coal, f.o.b. mines: Chicago, Wilmington & Franklin Coal Co., Chicago, $2.80 per ton; Crerar-Clinch Coal Co., $1.96; J. K. Dering Coal Co., $2.52, $4.95 delivered; Great Lakes Coal & Coke Co., $1.80; Great West Coal & Lumber Co., $2.96; O'Gara Coal Co., $2.80; Peabody Coal Co., $2.80; Wade Coal Co., $2.52; $4.525 delivered.

Maine Legislature Listens To Message on Water Power

Governor Brewster of Maine, in a special message which he read to the Legislature in joint convention on water power, on April 1, laid stress on the consideration by the Legislature of St. John River and the Passamaquoddy Bay water-power projects, both being of international interest.

The message told of the opportunities offered for a "grab" of the entire storage basin of the St. John River, in Maine, under the provisions of the mill act. The message also discussed the possibilities of danger threatening the Maine hydro-electric policy in the bill to incorporate Dexter R. Cooper with authority to develop tidal power at Passamaquoddy Bay.

Governor Brewster spoke in part, according to press reports, as follows:

"Our neighboring province of New Brunswick, with which we have long enjoyed most cordial relations, is now moving rapidly toward the consummation of a project which vitally affects the interests of the State of Maine.

"Grand Falls on the St. John River, three miles beyond our boundary, is a water power of the first magnitude, and its development by the Provincial government is now planned. According to the report of the Provincial Engineers, 73 per cent of the storage essential to the economical development of this water power is located within the state of Maine."

The Governor spoke of the advantages of this development to the two countries, but stated the position of Maine:

"The existing laws of the State of Maine, however, apparently leave us absolutely unprotected, if the Provincial Government shall decide to carry this project to completion before a change

in our laws is made. The course is astonishingly simple, and the initial step has already been taken, and it is further clearly evident that all of the steps in the sequence are already known to the authorities that are concerned.

"Application for the development of Grand Falls is now pending with the International Joint Commission. The initial dam of Grand Falls will flow back water for thirty-two miles, twenty-nine of which are along the International Boundary raising the level of the river 16 ft. above the low water, and flooding out approximately four hundred acres of land in the State of Maine, besides possibly overflowing certain lines of the Bangor and Aroostook Railway."

In regard to the Passamaquoddy Bay tidal scheme, the Governor believes that the Legislature should be, rather than any other, the agent for apportioning the power between New Brunswick and Maine.

Committee On Oil and Gas Power Week Offers Prize

The National Committee in charge of Oil and Gas Power Week, April 20-25, is announcing an award of a cash prize of $100 for the best contribution toward the conservation of oil and gas for power purposes. The contribution can be either in the form of a paper presented at one of the meetings that are being held throughout the country, or a written discussion of a paper, or an original essay not exceeding 5,000 words, by any one attending any of the oil and gas power meetings. Contributions should be in the hands of the National Committee, William E. Bullock, Cor. Sec., 29 West 39th St., New York City, not later than June 1. The prize will be awarded August 1, the National Committee acting as judges.

Personal Mention

Mason Britton, vice-president of the McGraw-Hill Co., Inc., and manager of the *American Machinist* sailed on the "Leviathan," on April 11 for a short business trip abroad.

William N. Brownlie, formerly with the British Thomson-Houston Co., Ltd., and more recently engaged in technical and sales duties with Messrs. R. L. Weir & Co., representing Seimens, Ltd., in South America, has joined Stone & Webster, Inc., as engineer in the electrical division at their Boston office.

C. E. Drayer, for seven years secretary of the American Association of Engineers, has resigned, effective April 1. Miss M. E. McIver, assistant editor of *Professional Engineer*, has been made acting secretary under Harold Almert, managing director. Difference of opinion with reference to the activities of the association led to the resignation.

Obituary

John Joseph Redmond, vice-president in charge of sales of the Fulton Iron Works, St. Louis, Mo., died at Recife, Brazil, on April 8. He had been ill for two weeks. Mr. Redmond, who was 29 years of age, entered the employ of the Fulton Iron Works Co. in 1915. He had been in South America since last September in the interest of the company but expected to return to St. Louis in a few months. He is survived by his mother and sister.

William Rufus Roney, of New York City, died on April 6 in Downers Grove, Ill., at the home of his daughter, and was buried at Mt. Adnah Cemetary, Annisquam, Mass. Mr. Roney, a prominent figure in the engineering field, was the inventor of power-plant equipment, principally the stoker bearing his name. For many years he was identified with the Westinghouse interests and lived in Pittsburgh and Boston. He was a life member of the A.S.M.E. He was a brother of Prof. Henry B. Roney of Chicago; Thomas C. Roney, of Los Angeles; of the late Prof. Thomas C. Roney, Dean of Armour Institute and of the late Charles J. Roney, one time secretary and librarian of the Western Society of Engineers, Chicago. Mr. Roney is survived by a widow, two daughters and one son.

Coming Conventions

American Boiler Mfg. Association, H. N. Covell, 7 East 19th Ave., Brooklyn, N. Y. Meeting at Glen Spring Hotel, Watkins, N. Y., June 1-3.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Niagara Falls, April 23-25.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Regional convention, at Swampscott, Mass., May 7-9. Annual convention at Saratoga Springs, June 22-26.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Society of Refrigerating Engineers. William H. Ross, 35 Warren St., New York City. Convention at Milwaukee, May 18-21.

American Water Works Association. W. N. Niesley, 170 Broadway, New York City. Convention at Louisville, Apr. 27-May 3.

American Welding Society, 29 West 39th St., New York City. Annual meeting at New York City, April 22-24.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Kansas Association** at Topeka, May 6-8. J. M. Van Sant, 739 Horne St., Topeka. **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at McAlpin Hotel, New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 10-12, formerly announced June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago. National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Society Affairs

The Bridgeport (Conn.) Section of the A.S.M.E. will hold a joint meeting with the Purchasing Agents on April 28. George Heilman, Otis Elevator Co., will speak on the "Purchase of Engineering Materials."

The Johns Hopkins University will have on April 29, in its course of lectures on engineering practice, "The Low Temperature Carbonization of Coal," by A. C. Fieldner, superintendent Pittsburgh Station, United States Bureau of Mines.

The Verein Deutscher Ingenieure (V.D.I.) will hold a joint meeting on "Coal and Combustion," with a number of prominent coal-mining, public-utility and steam-boiler societies at Essen, April 25 and 26. The program includes papers on coal preparation, coke production, the future chemical aspect in the liquefaction of coal and the present-day achievements in combustion of coal.

The Newcomen Society in North America, which is to be the American section of the old Newcomen Society of London founded for the study of the history of engineering and technology will hold its first meeting April 22 at the Engineers' Club, 32 West Fortieth St., New York City at 7 p.m. The dinner will be addressed by: L. F. Loree, president of the Delaware & Hudson Co.; Edward P. Hamilton, of Lowell, Mass., will present an abstract of his paper, "New England Wind Mills"; Dr. W. F. Durand, president of the A.S.M.E.; and Dr. Arthur M. Greene, Jr., Dean of Engineering at Princeton. Charles Penrose will preside.

Business Notes

Dayton-Dowd Co., Quincy, Ill., manufacturer of centrifugal pumps, announces the opening of a new office in Detroit at 841 David-Whitney Bldg., in charge of E. E. Maher and E. P. Johnson, and also the appointment of the

Power Equipment Co., 131 State St., Boston, Mass., to represent it in the New England district.

Chas. Cory & Sons, Inc., 183 Varick St., New York City, manufacturers of signal, control and lighting equipment, have opened an office in Chicago at 22 West Quincy St. Harry D'Almaine has been appointed Chicago district manager.

The Erie City Iron Works, Erie, Pa., announces changes in personnel: Hays H. Clemens was elected president, succeeding Edward C. Moore, who remains as vice-president and treasurer; L. V. Reese, general manager was elected secretary and will hold that office in addition to his present duties; A. R. Horr and Ely Griswold complete the board of directors.

The Walworth Manufacturing Co., Boston, Mass., announces the formation of an Engineering Products Division for development and distribution of valves and fittings for power plant and oil-refinery service. John M. Olmstead has been appointed general manager of the division with headquarters in Chicago, and Fred W. Duemler, assistant manager, located in New York City.

Industrial Works, Bay City, Mich., announces the following changes in its organization: Lyle Marshall, former manager of the service department and later connected with the Chicago office, has been appointed district sales manager, with new offices at 619 Dixie Terminal Bldg., Cincinnati, Ohio; James E. Shearer, assistant sales manager, has moved his headquarters from Bay City to 50 Church St., New York City; George T. Sinks, in charge of the New York district, will remain in that position.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	April 13, 1925
Pool 1	New York	$2.35@$2.85
Smokeless	Boston	1.63
Clearfield	Boston	1.75@ 2.20
Somerset	Boston	1.90@ 2.35
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.35@ 1.50
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.60@ 1.70
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.00@ 2.25
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.25@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$3.00
Buckwheat No. 1.	Philadelphia	2.00@ 2.50
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—Apr. 16, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Apr. 7, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2.00 per bbl.; 30@32 deg., $2.05 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.7c. per gal.

Pittsburgh—Apr. 14, f.o.b. local refinery; 30@34 deg. fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Apr. 11, f.o.b. local refinery, 26@30 deg., $1.55 per bbl.

Philadelphia—Apr. 10, 28@30 deg. $2.31@$2.373 per bbl.; 18@22 deg., $2.184@$2.247; 13@16 deg., $2.06@ $2.123 per bbl.

Boston—Apr. 13, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4⅝c. per gal.; light oil, 28@32 deg. Baumé, 6c. per gal.

Cincinnati—Apr. 14, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¾c. per gal.; 26@30 deg., 6c. per gal.; 30@32 deg., 6¼c. per gal.

Trade Catalogs

Forged Steel Pipe Flanges.—The American Spiral Pipe Works, P.O. Box 485, Chicago, Ill. This catalog contains a table of contents on page 5 which, strange to say, fills nearly the entire page with lists of tables and data such as drilling templates, nut clearances, bolt stresses, American standard threads, riveted-pipe-flange standards, wrought-iron pipe dimensions, etc. Although the manufacturer's products are also adequately described, the keynote of the pamphlet is thus emphasized—useful information for the engineer. Data of particular interest are the recent standards regarding flanges for 400, 600 and 900 lb. Opposite almost every table is an entire page of illustrative matter. Instead of the usual illustrated catalog therefore, there is to all intents and purposes a convenient handbook of piping information, which also contains descriptions of apparatus manufactured. The information therein, as well as the fine manner of execution, will make this a welcome addition to the published material ordinarily used in connection with power-plant work.

New Plant Construction

Ariz., Phoenix—Salt River Valley Water Users, voted $450,000 bonds for sinking about 20 new wells and installing 5 pumping stations. C. C. Cragin is Engineer.

Ariz., Winslow—City is having plans prepared for 10,000 cu.ft. per hr. capacity oil gas generator, with scrubbers; 80 hp. return tubular fire box; 150 lb., pressure boiler; filters, purification set, etc., for gas plant. Estimated cost $50,000. H. R. Lendecke, is city engineer.

Ark., Cotton Plant—City will receive bids in June for waterworks pumping equipment, tank on tower, etc. Also sanitary sewer system. Estimated cost $125,000. E. T. Archer & Co., 612 New England Bldg., Kansas City, Mo., are engineers.

Calif., Del Monte—Del Monte Properties Co., 620 Market St., awarded contract for the construction of a hotel, to Lindgren-Swinerton, Inc., Standard Oil Bldg., San Francisco. $1,500,000. Cost plus basis.

Calif., Fresno—San Joaquin Light & Power Co. will build the Balch power plant, 37,500 hp. hydro electric, operating under head of 2,470 ft. tunnel, transmission lines, etc., on the north fork of Kings River, about 55 miles east of here. Estimated cost $4,500,000. Engineering department of company in charge.

Calif., Los Angeles County—Bd. of Public Works, will receive bids until April 27 for triplex pump and motor. H. A. Van Norman, City Hall, is city engineer.

Calif., Los Angeles — Pacific National Bank Bldg., is receiving bids for the construction of a 12 story, bank and office building, including steam heating system, at 9th and Hill Sts. Estimated cost $1,000,000. Morgan, Walls & Clement, 1124 Van Nuys Bldg., are architects.

Calif., Manteca—South San Joaquin Irrigation Dist., Manteca and the Oakdale Irrigation Dist., Oakdale, plan election to vote $2,200,000 bonds for the construction, of Melones project, including dam, tunnel, and pumping plant. The power plant in connection with the project will be built by the Pacific Gas and Electric Co., P. G. & E. Bldg., San Francisco.

Calif., San Luis Obispo—City, plans an election to vote $40,000 bonds for construction of lighting plant.

Calif., Stockton—F. T. Mayo, 21 South San Joaquin St., Archt. is preparing plans for the construction of a 12 story, office and stores building, for a group of San Francisco capitalists. Estimated cost $650,000.

Conn., New Haven—American Steel & Wire Co., 237 Fairmount Ave., awarded contract for alteration of boiler house, etc., to Standard Construction Co., 153 Court St. Estimated cost $45,000.

Fla., Jacksonville — San Jose Estates Corp., H. P. Oaborn, Pres. plans the construction of a hotel on St. John's Rd. between South Jacksonville and La Vista Aves. Estimated cost $750,000.

Fla., St. Petersburg—Ground Bros. Mfg. Co., plans the construction of a sash and door factory, with 300 hp. power plant at 24th St. and 7th Ave. Estimated cost $100,000.

Ga., Louisville—City plans the construction of an electric light plant. Estimated cost $50,000.

Ill., Chicago—L.O.O.M., Chicago, No. 1, B. Johnson, Secy., 155 North Clarke St. plans the construction of a hotel and office building. Estimated cost $2,000,000. Architect not selected.

Ill., Murphysboro — R. & E. Stecher, awarded contract for the construction of an ice plant, to E. Friens. Estimated cost $50,000.

Ill., Springfield—Bd. of Trustees, S. S. Breese, Pres. Sanitary Dist., City Hall, will receive bids until May 5, for sewage improvements, including Division B, construction of Cook St. pumping station and Division D, 5 electric motor driven vertical, centrifugal pumps with an aggregate capacity of 18,000,000 gal. per day.

Ind., Anderson—Bd. of Public Works, City Hall, R. Creason Clk., will receive bids until May 4, for 60,000 kw. generator, with appurtenances and condensors, for light and power plant. Estimated cost $100,000. E. H. Driscoll is superintendent of plant.

Ind., East Chicago—Bd. of Public Works will receive bids until April 29, for the construction of sewage pumping station, with equipment and accessories, on Alder St. Greeley & Hansen, 6 North Michigan Ave., Chicago, are consulting engineers.

La., Donaldsville—City plans an election April 21, to vote $70,000 bonds for construction of combination water and light plant. Water pumping equipment, dynamos, etc., will be purchased.

La., New Orleans—J. W. Billingsley, Interstate Bank Bldg., is in the market for a 350 kw. engine driven, electric generator unit, 480 v., 3 phase, 60 cycle.

La., Shreveport—L. P. Florida, E. K. Ligrett, et. al. Memphis, Tenn., is having plans prepared for the construction of a 7 story apartment hotel, at Elizabeth St. and Margaret Pl. Estimated cost $550,000. Wittenberg, Deloney & Watts, Little Rock, Ark. are architects.

Md., Baltimore—I. Silberstein, et. al., 402 St. Paul St., is having preliminary plans prepared for the construction of a 18 story, hotel and stores building, at North and Maryland Aves. Estimated cost $1,000,000. A. L. Harmon, 19 West 14th St., New York, is architect.

Mass., Reading — Town voted $135,000, for addition and improvements to municipal electric lighting plant. Engineer not selected.

Mich., Detroit—Book Estate, Book Bldg., Washington Blvd., is having plans prepared for the construction of a 35 story, office building at Washington Blvd. and Grand River Ave. Estimated cost $3,000,000. L. Kamper, 3729 Cass Ave., is architect. Steam heating equipment, boilers, etc. will be required.

Mich., Detroit — Immaculate Heart of Mary, St. Mary's College, 1219 Washington Blvd., awarded contract for the construction of a group of buildings, including a power house, on Wyoming Ave. to W. E. Wood Co., Ford Bldg., $2,500,000.

Mich., Detroit—Public Welfare Commission, Clinton & Raynor Sts., having revised plans prepared for the construction of a 9 story hospital with detached power plant, on Clinton St. Former bids rejected. Estimated cost $900,000. Carey & Esselstyn, 2539 Woodward Ave., are architects.

Miss., Hernando—City voted $20,000 bonds for construction of waterworks including pumping equipment and distribution system.

Mo., Eminence — Shawnee Copper Co., R. E. Carr, Secy., is in the market for 75 hp. Corliss steam engine, 125 hp. boiler and 400 cu.ft. air compressor, steam driven, for proposed milling and concentrating plant. Engineer not selected.

Mont., Troy — Great Northern Railway Co., Railroad Bldg., St. Paul, Minn., awarded contract for improvements, including a 38 x 58 ft. power house, here, to S. J. Siverson, 3100 43rd Ave., Minneapolis.

Neb., Alliance—City is having preliminary surveys made for water and light improvements, by Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., Engrs.

Neb., Crofton—City plans light and power plant improvements, including new engine, generator, switchboard, etc. Estimated cost $6,000.

N. J., Trenton—Bd. of Alderman, J. Kelley, Pres., is in the market for equipment for city pumping station, including motors, pumps, transformers, switchboards, etc. Estimated cost $45,000.

N. J., Trenton—Public Service Corp., 80 Park Pl., Newark, T. N. Carter, Pres. plans the construction of a substation for distribution of power received from Philadelphia, here. Estimated cost $2,000,000. Work will be done by separate contracts.

N. Y., New York—A Brisbane, 238 William St., is having plans prepared for the construction of a 22 story, apartment house, including steam heating system, at 6th Ave. and 54th St. E. Roth, 119 West 40th St., is architcet.

N. Y., New York—Phipps Estate, c/o G. F. Pelham, 200 West 72nd St., Archt., is having plans prepared for the construction of a 15 story, apartment house, at Madison Ave. and 69th St. Estimated cost $1,000,000.

N Y., New York—L. and J. J. Shubert, 223 West 44th St., is having plans prepared for the construction of a 14 story office building including steam heating system at 236 West 44th St. H. J. Knapp, 1650 Broadway is architect.

O., Ashtabula—T. P. Fitzgerald and W. Johnson are having plans prepared for the construction of a commercial and market house, including refrigeration and steam heating systems. Estimated cost $150,000. McGarvey & McGarry, 4614 Prospect Ave., Cleveland, are architects.

O., Dover—City will receive bids until April 29, for the generating unit, at power plant, including steam engines, and turbines from 500 to 750 kw. capacity, with complete auxiliary equipment. Estimated cost $50,000.

O., Painsville — City, will receive bids until April 23, for waterworks improvements, including construction of 35 x 80 ft. pump room, etc. Hadlow, Hick & Co., Cleveland, are engineers.

Okla., Altus—City, S. E. Hickman, Mayor, is having plans prepared for waterworks improvements, including construction of pump station, and dam, at Bitter Creek. Estimated cost $39,000. M. M. Oates, is engineer.

Okla., Boynton—Transcontinental Oil Co., 525 Equity Bldg., Muskogee, will build an oil refinery by day labor, here, equipment includes two 150 hp. boilers. A. J. Slagter, Gen. Supt. is architect and engineer.

Okla., Carter—City, G. C. Mitchell, Clk., will receive bids until April 27 for 18 miles of 13,200 v. transmission lines, 50, kw. step down station, and electric distribution system. Estimated cost $25,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Henryetta—City, H. W. LaRue, Supt. of waterworks, is having preliminary plans prepared for the construction of 2 units to present filter system, including pumping equipment. Estimated cost $40,000. Engineer not selected.

Okla., Holdenville—City voted $128,000 bonds for waterworks improvements including pump station, pumps, motors, valves, etc., also small dam. Estimated cost $128,000. V. V. Long & Co., Oklahoma City are engineers.

Okla., Muskogee—City is having preliminary plans prepared for the construction of a 6,000,000 gal. filter plant, with motor driven pumps, etc. Estimated cost $125,000. J. R. March is city engineer.

Okla., Newkirk—City, C. S. Miller, Mayor, voted $115,000 bonds for waterworks improvements including 5 mile pipe line, wells, motor driven pumps, etc. F. B. King, Grain Exchange, Oklahoma City, is engineer.

Okla., Spiro—City, M. L. Coon, Mayor, is having preliminary plans prepared for new waterworks system, including deep well pumps, motors, reservoir, etc. Estimated cost $20,000. Architect not announced.

Okla., Stigler—City, T. W. McKinley, mayor, is having preliminary plans prepared for the construction of a new filter plant with pumping equipment, etc. Estimated cost $35,000. V. V. Long & Co., Colcord Bldg., are engineers.

Okla., Wewoka—City, J. R. Fraser, Clk., is receiving bids for waterworks and sewer improvements, including pumping equipment, etc. Estimated cost $200,000. V. V. Long & Co., Oklahoma City, are engineers.

R. I., Providence—Narragansett Electric Co., awarded contract for the construction of a turbine building, to S. C. Sperry Co., 293 Main St., Cambridge, Mass.

Tex., Bay City—City is having preliminary plans prepared for extensions to waterworks system, including mains and pumping equipment. Estimated cost $60,000. Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Texas, Dallas—E. C. Pankhurst, Adolphus Hotel, is having plans prepared for the construction of a 10 story apartment at Maple and Fairmount Aves. Estimated cost $1,250,000. Young & Young, 207 S. W. Life Bldg., is architect.

Tex., Houston — Turning Basin, Dist. Navigation Dist., c/o H. L. Washburn, county auditor, Court House, is having plans prepared for 20 x 50 ft. transformer station. Owner taking bids for electric equipment, including transformers, circuit breakers, switchboards, etc. Estimated cost $40,000.

Tex., Houston—H. L. Washburn, County Auditor, Court House, will receive bids until April 30, for the construction of a new fire boat equipped with twin screw, Diesel electric engines, two 35,000 g.p.m. pumps, under 150 lb. pressure. Estimated cost $300,000. J. A. Schiller, is engineer.

Tex., Irving—City, Fresh Water District, L. Hancock, Secy., is receiving bids for the pumping equipment for waterworks improvements. Estimated cost $55,000. Koch & Fowler, 606 Central Bank Bldg., Dallas are engineers.

Tex., New Braunfels—San Antonio Public Service Co., 201 North St. Marys St., San Antonio, E. F. Kifer, Gen. Mgr. awarded contract for the construction of a power plant to generate 30,000 hp., on the Guadalupe River, near here, to U. G. I. Contracting Co., Broad and Arch Sts., Philadelphia, Pa. Estimated cost $3,000,000.

Tex., San Antonio—State has appropriated $36,000 for the construction of a water pumping plant, at Southwestern Insane Asylum. Pumping equipment and boilers will be purchased. C. W. Cathner, is superintendent of asylum.

Tex., Temple—City voted $50,000 bonds for waterworks improvements, including new pumping equipment, etc. H. J. Grusser is city manager.

Tex., Victoria—City plans election May 14, to vote $100,000 bonds for construction of a water and electric light plant including equipment.

Tex., Wharton—City is having preliminary plans prepared for the construction of extensions to waterworks system, including new well, pumping equipment, etc. Estimated cost $40,000. Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Tex., Wichita Falls—City, is receiving bids, for waterworks improvements, including pumping equipment, etc. Estimated cost $35,000. Montgomery & Ward, 1016 City National Bank Bldg., are engineers.

Wash., Oroville—Okanogan Valley Power Co., plans the development of a 2,500 hp. light and power plant, and has applied to the State Highway Department for 50 year franchise, to construct and operate electric transmission line on the Cjelan and Okanogan Highways.

Wash., Tacoma—Cascade Paper Co., West Tacoma plans the construction of a new pulp mill, at plant on Chambers Creek, including boiler room, etc. Estimated cost $400,000.

Wis., Fond du Lac—Bd. of Public Works awarded contract for the construction of 44x160 ft. addition to pumping station, to Immel Construction Co., Dana Bldg. $19,624.

Wis., Iron River—Iron River Packing Co., c/o D. J. Fitzgerald, 722 Werle Ave., Wausau, Mgr., will soon award contract for the construction of a cannery and 30 x 40 ft. boiler house. Estimated cost $60,000.

Wis., Madison—J. Heilprin Fruit Co., West Mifflin St., awarded contract for the construction of a cold storage plant, to Wells Construction Co., 1136 Lumber Exchange, Minneapolis, Minn. Estimated cost $50,000. Ice and refrigeration machinery will be required.

Wis., Milwaukee—Metropolitan Sewerage Commission, 508 Market St., is having plans prepared for the construction of booster stations at 41st St. and Park Hill Ave., and Lake Drive and Fairmount Ave. Estimated cost $40,000. Centrifugal pumps or sewage ejectors will be purchased. T. C. Hatton, 508 Market St., is engineer.

Wis., Milwaukee—A. Weinbrenner Co., 66 Juneau Ave., awarded contract for the construction of a 3 story factory with 20x38 ft. boiler house on Richards St., to P. Riesen's Sons, 1018 Humbolt Ave. Estimated cost $75,000.

Wis., Stevens Point—A. Shafton & Co., South 2nd St., plans the construction of a cold storage plant. Estimated cost $40,000. Refrigeration machinery will be required.

Wis., Sturgeon Bay—Reynolds Preserving Co., awarded contract for the construction of cannery and 20 x 40 ft. boiler house, to DeFault & Hirsch. Estimated cost $50,000.

Ont., Brockville—Hydro Electric Power Commission, 190 University Ave., Toronto, plans surveys for hydro electric development, on the Gananoque River, in Leeds County, near here, to develop 5,000 hp. Estimated cost $750,000. F. A. Gaby, 190 University Ave., is chief engineer.

Ont., Guelph—City, is having plans prepared for the installation of a central heating system, for the general hospital. Estimated cost $45,000. Steam boilers, feed pumps, vacuum pumps, etc., will be required. N. S. Nicklin, City Hall, is city engineer.

Ont., Hamilton—City plans to increase to capacity of pumping station at Burlington and Gage Aves., from 20,000,000 to 68,000,000 gal. per day. Estimated cost $100,000. Equipment, including 48,000,000 gal. capacity, 3 stage electric centrifugal pumps, will be required. W. L. McFaul, City Hall is engineer.

Ont., Humberstone—Town Council is having plans prepared for waterworks system, including pump house, reservoir, etc. Estimated cost $30,000. Centrifugal pumps, electrically driven, will be required. A. W. Conor, & Co., Royal Bank Bldg., Toronto, are engineers.

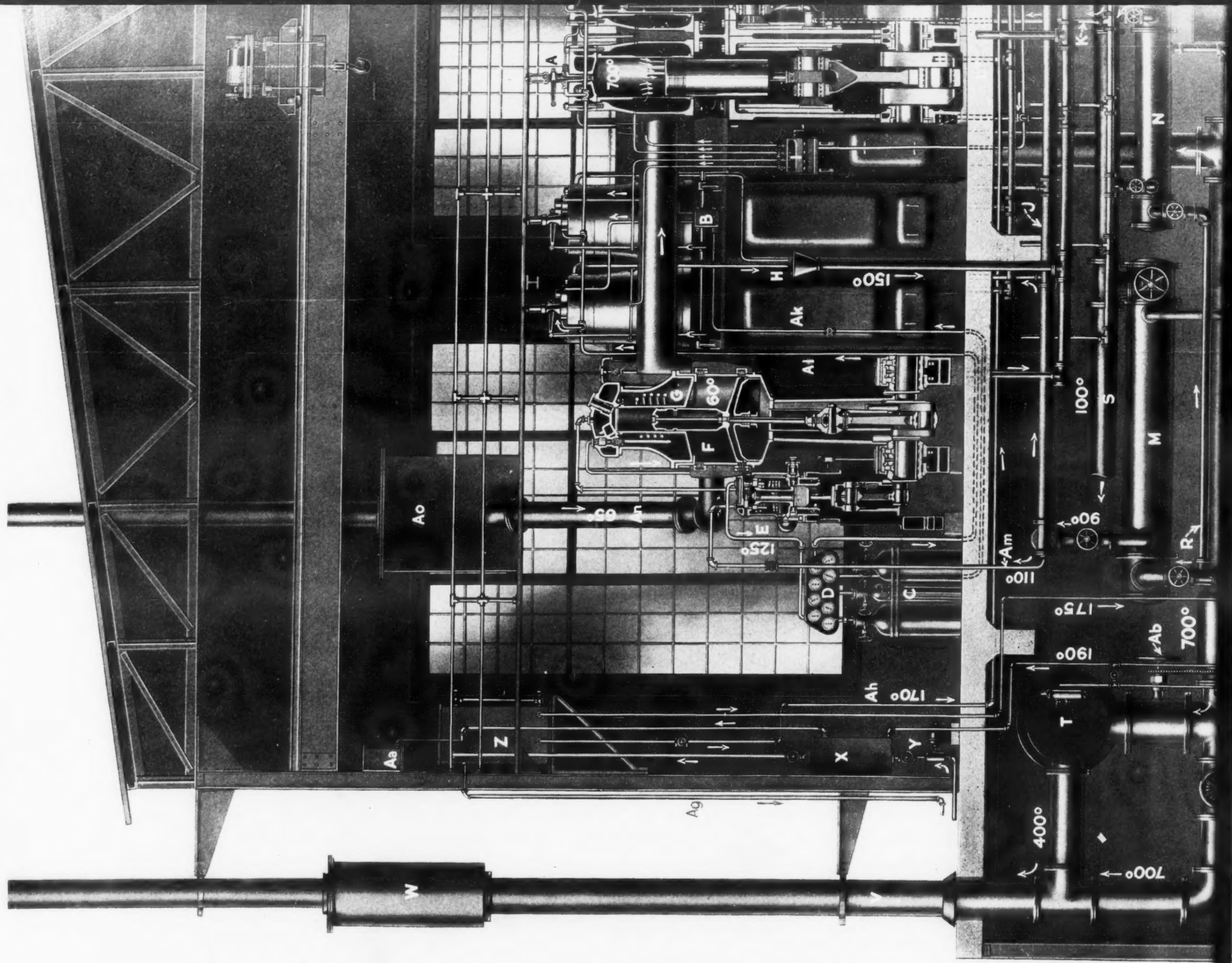
Ont., Kagawong—Little Rapids Pulp Co., awarded contract for pulp mill, on Manitoulin Island, to W. E. Ule, Stevens Point, Wis. Estimated cost $200,000. Equipment including 1,200 hp. and 500 hp. water wheels, 90 kw. generator, conveyors, etc., will be purchased.

Ont., Kenora—Backus Brooks Co. plans the construction of a 1 and 2 story newsprint mill, to increase capacity of plant from 100 to 250 tons per day. Estimated cost $1,500,000. Newsprint machines, grinders, motors, switches, etc., will be purchased. T. T. McLennan, Kenora, is engineer.

Ont., Larder Lake—Crown Reserve Mining Co., plans the construction of a mining mill, with 200 ton daily capacity. Estimated cost $250,000. Equipment, including pumps, motors, etc., will be required.

Ont., Toronto — Province of Ontario, Parliament Bldg., awarded general contract for the construction of a 6 story, office building, at Queens Park, to Jackson Construction Co., Ryrie Bldg., $1,750,000. Steam heating system will be installed.

Ont., Waterford—City will receive bids about May 1, for waterworks equipment, including pumps, etc. Estimated cost $55,000. C. G. Fairchild, 169 Colborne St., Bradford, is engineer.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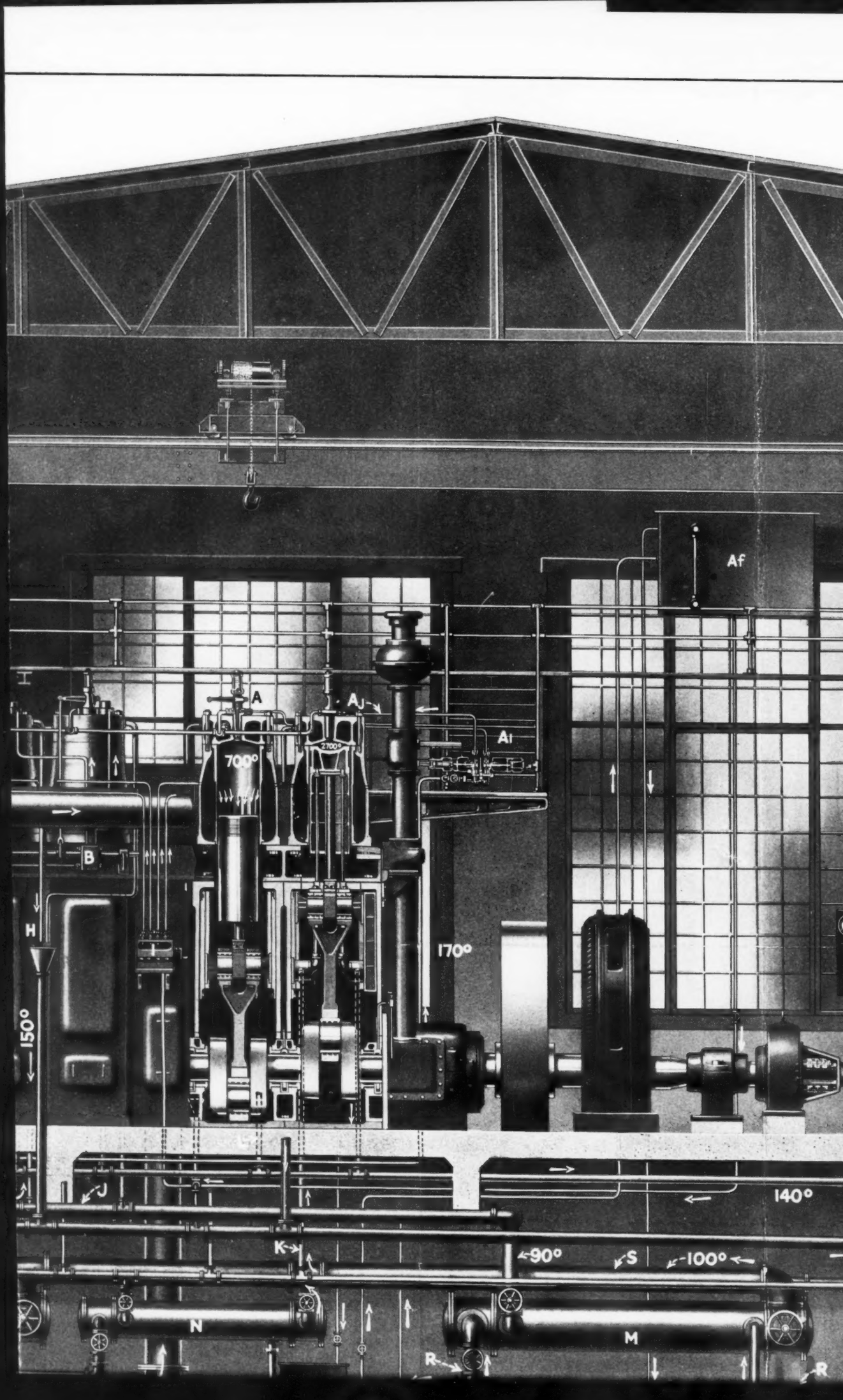
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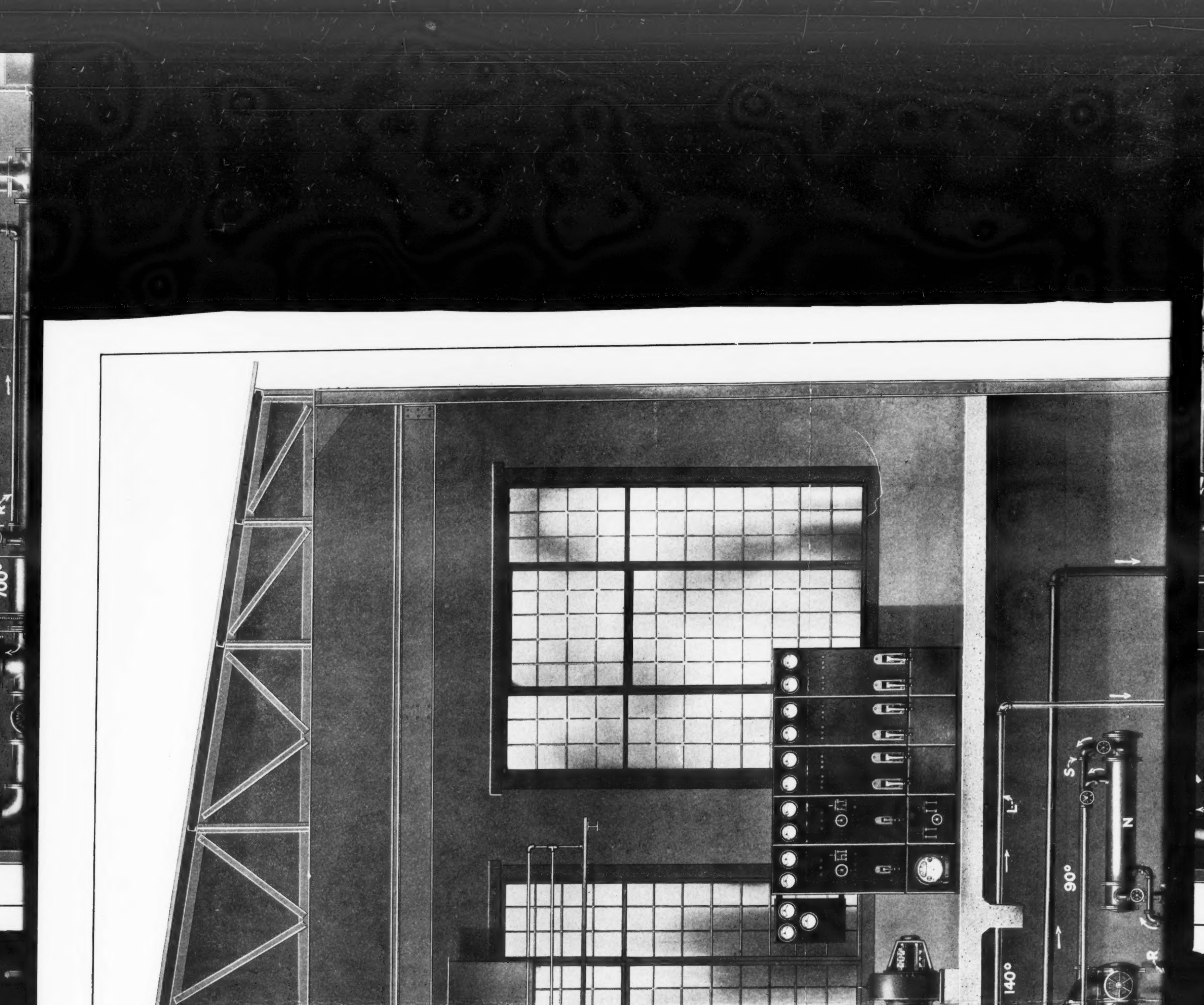
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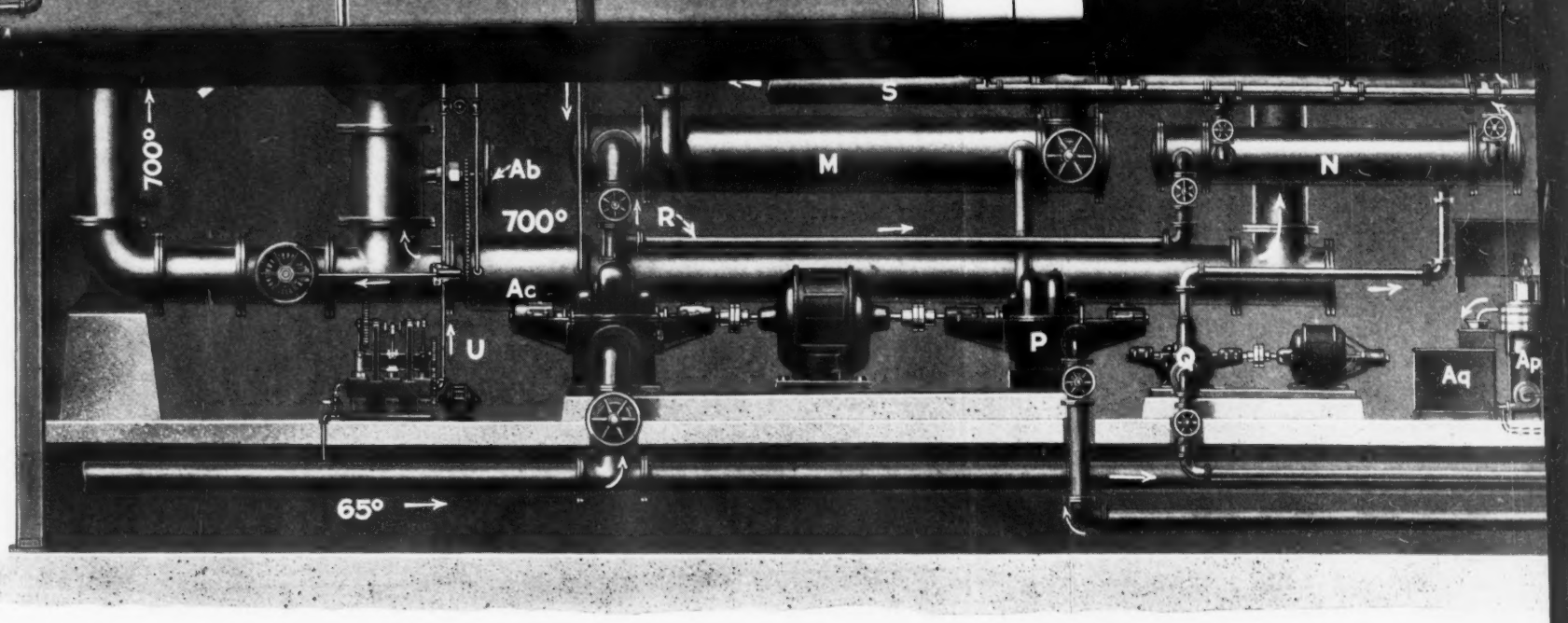

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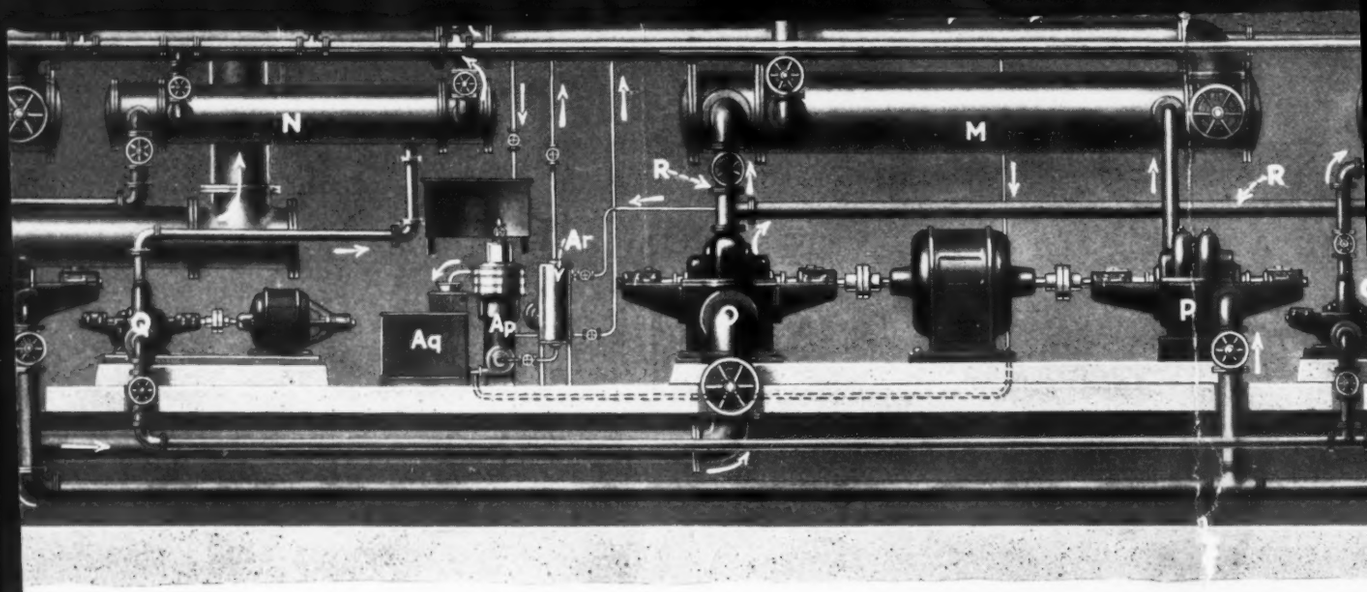
Typical Dies

A. Fuel spray valve.
B. Air starting pilot gear.
C. Air bottles.
D. Gage board.
E. Air compressor.
F. Scavenging air pump.
G. First stage of air compressor.
H. Cooling water from cylinders.
I. Mechanical lubricator.
J. Cooling water to cylinders.
K. Cooling water to pistons.
L. Cooling water from pistons.
M. Cylinder cooling-water shell cooler.
N. Piston cooling-water shell cooler.
O. Raw water pump.
P. Cylinder cooling water pump.
Q. Piston cooling water pump.
R. Raw-water line to coolers.
S. Raw-water discharge line.
T. Waste-heat boiler for cooling water make up.
U. Waste-heat boile
V. Engine exhaust
W. Exhaust silence
X. Fuel-oil filters.



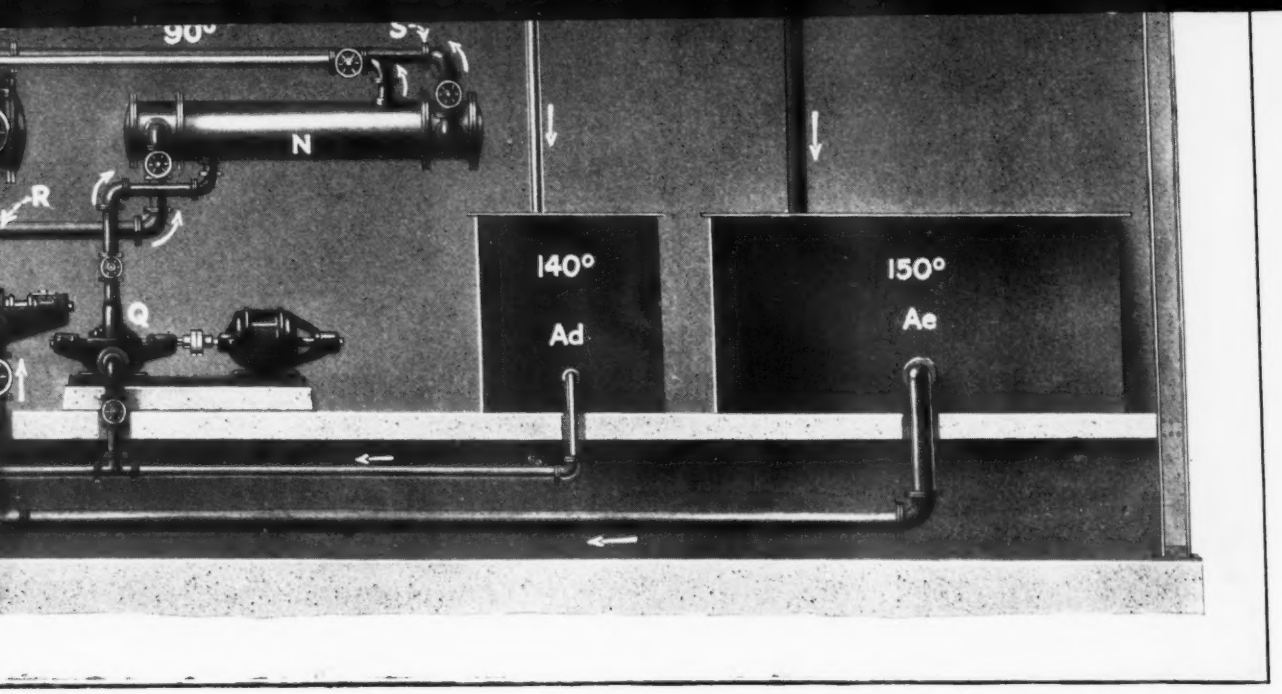
Typical Diesel Engine Power Plant

w-water line to coolers.
w-water discharge line.
aste-heat boiler for cool-
ing water make up.

U. Waste-heat boiler feed pump.
V. Engine exhaust pipe.
W. Exhaust silencer.
X. Fuel-oil filters.

Y. Fuel-oil pumps.
Z. Fuel-oil service tank.
Aa. Expansion tank for oil-heating system.

Ab. Bypass valves for waste-heat boiler.
Ac. Hot-water heater for fuel-oil heating.



for waste-

ter for fuel-

Ad. Piston cooling-water tank.
Ae. Cylinder cooling-water tank.
Af. Lubricating-oil tank.
Ag. Fuel-oil overflow.
Ah. Oil line to engine fuel pump.
Ai. Engine fuel injection pump.
Aj. Fuel oil to spray valve.
Ak. Air line to air-starter valves.
Al. Air line to cylinder spray valves.
Am. Cooling water to compressors.
An. Scavenging-air intake pipe.
Ao. Scavenging-air filter.
Ap. Centrifugal lubricating-oil purifier.
Aq. Lubricating-oil filter.
Ar. Lubricating-oil cooler.